THURSDAY, JANUARY 16, 1879

A SCOTTISH METEOROLOGICAL MOUNTAIN OBSERVATORY

IT is the opinion of those best versed in meteorological science, that much valuable information regarding the constitution of the earth's atmosphere, and the laws which determine the changes in the atmosphere, is to be obtained by observations at elevated stations. To quote the words of the distinguished French philosopher, Biot: "It is in the high regions of the air that meteors are formed, rain, snow, and hail. There the thunder rolls and the lightning traces its furrows. There the aurora displays its plume of light, and the aerolite shines and bursts. There are the upper currents which chariot the clouds. It is to these elevated regions that the inquirers of meteorological science ought to be directed."

For want of permanent stations at high levels, attempts have been made to explore the upper regions of the atmosphere in balloons. In the year 1862, Mr. Glaisher—at much personal peril—accomplished about thirty ascents with instruments which enabled him to ascertain with some precision the aerial temperature, humidity, clouds, and other phenomena, up to a height of several miles. More recently, Tissandier, in France, made twenty-four ascents in balloons, also with the result of obtaining valuable information on these points. Since February, 1877, Secretan, an enterprising optician in Paris, has been sending up small exploring balloons, for ascertaining the height of clouds and the direction of the aerial currents up to about 1,200 metres.

The value of the data obtained by these casual explorations has led meteorologists to a more systematic study of the upper regions of the atmosphere.

Thus Dr. Hildebransen, of Upsala has been devoting himself to a study of clouds, to ascertain their altitude, movements, and shapes at different seasons; and he has recently issued a circular to meteorologists in other countries, pointing out the importance of the inquiry, and inviting co-operation.

It has been recently discovered in France, by observations at the Montsouris Observatory, that *dust* of various kinds is at most seasons of the year floating in the atmosphere, consisting of spherules so minute as to be discernible only by the microscope or by chemical tests: and that which so floats is not always the same in the higher as in the lower regions of the air. The bearings of this new information on epidemics affecting both animal and vegetable life is awakening much attention among continental physicists.

These remarks refer to the information afforded by meteorological observations at high stations regarding the constitution of the atmosphere or the ingredients existing in it. But there is another use to which high-level stations can be and are applied, viz., to furnish early intimation of changes in the weather. It appears from the observations made at the high-level stations of the Scotch Meteorological Society, that changes of temperature take place in the upper regions from twenty-four to thirty-six hours sooner than in the same district at ordinary low levels. Lately Prof. Loomis has been comparing the observations made at high-level and low-level stations in America, and he finds a considerable difference, not only in the speed and direction of the wind, but even in the barometric pressure.

In these circumstances it is not surprising that scientific meteorologists in all countries should in addition to low-level stations have made strenuous efforts to obtain also stations at high levels, and that they have been to a large extent successful. Thus in France two meteorological stations have lately been formed on the Puy de Dôme and the Pic du Midi, at heights respectively of 4,809 and 9,439 feet above the sea. In Austria Dr. Hann, one of the ablest European meteorologists, with Government aid, established a station in Upper Carinthia at a height of 8,000 feet above the sea. There are three stations in Italy, at heights respectively of 7,087, 8,343, and 8,360 feet above the sea, and a fourth is about to be established on Mount Etna, at the Casa Inglese, at a height of 9,652 feet above the sea. In Switzerland there is a station at the Hospice of St. Bernard, at 8,130 feet above the sea. In the United States the meteorological station at Mount Washington is 6,600 feet, Mount Mitchell 6,691 feet, and at Pike's Peak (Colorado State), 14,216 feet above the sea; all of these stations were established by the Government, which also supplies instruments and pays the observers, who are soldiers.

Such being the state of matters in foreign countries as regards high-level stations, what is the case in Great Britain?

It is believed that in England the highest meteorological station is 1,372 feet above the sea; and that in Scotland the two highest are, respectively, 1,334 and 1,450 feet. It is matter of regret that in both England and Scotland there should not be stations at higher points, seeing that there are in both countries favourable positions for such. That regret has been repeatedly expressed by authorities to whose opinion some regard might have been expected to be paid. In February, 1877, the president of the English Meteorological Society, in his address to the Society, pointed out that "the most obvious way of gaining a clearer insight into the condition and movements of the gaseous envelope of the earth, is by the establishment of observatories on isolated mountain peaks. The value of this arrangement had been practically recognised abroad, and might well be imitated on some of our highest hills, such as Skiddaw in the north of England, or on the western seaboard of Ireland or Scotland, where their fitness as outposts, for giving early indications of storms from the west, would soon be appreciated."

The suggestion of high-level stations has been repeatedly made by the Scotch Meteorological Society. Thus, in July, 1875, the Chairman of that Society, after alluding to the value of the observations at the American high-level stations, observed that, so impressed was the Society's Council with the importance of high-level stations, that, if funds were forthcoming, "probably the very first thing which the Council would endeavour to do would be to establish stations on the two highest points of Scotland, viz., Ben Nevis on the west coast, and Ben Macdhui on the east coast, and, by means of intermediate stations on the sides of these mountains, obtain as suggested by Mr. Stevenson, vertical meteorological sections of the atmosphere."

Again, at a general meeting of the Scotch Society in July, 1877, the Chairman, in his address, renewed his reference to the desirability of a station on, at all events, Ben Nevis, and mentioned that Lord Abinger, the proprietor, having consented to the erection of a hut for the purpose, "the Society's Council would readily establish the station if it only had the requisite funds." Testimony to the value of high stations has in like manner been given by Mr. Robert Scott, the Secretary of the Government Meteorological Department.

Mr. Scott was the first and principal witness examined before the recent Government Meteorological Commission, and his opinion on the point of high-level stations is shown by the following questions and answers :—

Q. Has the Meteorological Committee felt it desirable to have stations at some higher levels in Great Britain?
A. Certainly they have.
Q. Have they thought of any particular plan?
A. They have had no money for it.
Q. Have they thought of any place if they had money?
A. I may mention Settle, because there is a telegraph station there, a high-level station, about 1,000 feet above the sea, on the borders of Yorkshire and Lancashire. If ever we had 30*l.* a year to spare, we should like to have a station there. It is found in cold weather that warm weather sets in at the upper stations perhaps one or two days before it comes down.

When such are the opinions which have been expressed and brought before the country by authorities deserving of respect and attention, it is hoped that the establishment of high-level meteorological stations will be no longer delayed. It is true that none of the mountains in the United Kingdom are so high as in the other countries above enumerated where high-level stations have been and are about to be established. But on the other hand the British Isles occupy a position more important for meteorological purposes than almost any other European country, inasmuch as their westward position enables British meteorologists to obtain the earliest information regarding the great storms which sweep across the Atlantic, and of which warning as soon as possible should be given in Europe. Great Britain's duty, interest, and credit as a nation concur therefore in this matter; and it is hoped that measures will soon be taken to establish these high-level stations in the three divisions of the United Kingdom, unless, in fact, we are prepared to see the problems presented by the phenomena of the higher air worked out in other countries.

COAL

Coal: its History and Uses. By Professors Green, Miall, Thorpe, Rücker, and Marshall, of the Yorkshire College. Edited by Prof. Thorpe. (London: Macmillan and Co., 1878.)

I SHALL be much surprised if this composite little volume fails to attract the attention of many students of nature, but especially of such persons as are practically connected with coal, either as students, as proprietors, or as workers. The five professors of the Yorkshire College of Science who have combined to produce the volume are men thoroughly competent to deal with the portions of the subject which they have severally undertaken, and the result of their labours is a book at once picturesque and scientific.

Prof. Green commences the work by two chapters on the geology of coal. After dealing with the general phenomena of the deposition of sandstones, shales, and limestones, he proceeds to examine the special features of coal and the probable conditions attending its formation. In doing so he grapples with the peculiar questions connected with the well-known lamination of coal and the alternation of the brittle, lustrous, bituminous layers with those of the so-called mother-of-coal or mineral charcoal. This subject of course raises the question of the origin of these two elements—a question which still presents curious and unsolved difficulties. The mineral charcoal chiefly consists of cubical fragments of bark mingled with some vascular or woody elements of plant-stems. Prof. Green correctly points out that "the woody character of this mother of coal is palpable even to the unaided eye," further adding "that it is possible, in some cases, to say what the plant was of which they (*i.e.*, the fragments of charcoal) originally formed a part." I am afraid that this latter feat is not easily performed. The vascular tissues which we chiefly find in this mineral charcoal are not those seen in Lepidodendron and in Sigillaria. The absence of the latter structures is one of the facts not easily explained. The vessels forming the ligneous zones of these two representatives of the carboniferous flora are always of the barred or pendoscalariform type. The dominant element in the mineral charcoal consists of the various modifications of cellular tissue found in the bark of these, and many other unrecognisable, plants, but the vessels are mainly of the reticulated type. They closely resemble the vascular elements found in some Calamites, in most Asterophyllites and Sphenophylla, and in all the known Lyginodendra. Whether the barred vessels of the Lycopodeaceous plants did not form a part of the vegetable mass converted into coal, or whether, being there, they were, bituminised more readily than others, is not easy to say. I am inclined to believe in the latter explanation; anyhow, I have as yet failed to find a solitary fragment of one of these *barred* vessels in the mineral charcoal. A fragment of American coal, sent to me many years ago by that distinguished microscopist, Dr. Bailey, of West Point, consisted wholly of numerous layers of similar reticulated vessels which had not undergone bituminous disintegration. The laminæ of mineral charcoal alternate with those of the more bituminised coal with great irregularity; in some specimens they are distributed in about equal quantities, in others thick bituminous layers separate the charcoal layers very widely. Whatever the agency may have been that brought about the result, this lamination shows that, in most instances, there have been irregularly recurring periods when innumerable, perfectly carbonised, but only partially disorganised, fragments of certain decaying stems were strewed over the surfaces of those portions of the vegetable mass which became converted into the more bituminous laminæ of the coal. In other cases I find no difficulty in seeing the charcoal intermingled with, and actually undergoing conversion into, the bituminous condition, whilst interposed layers of perfect macrospores have undergone no such conversion. The charcoal fragments are

precisely such as we see when an old post, or the stem of a dead tree, undergoing decay, is breaking up into small cubical or rectangular pieces, and which would float freely upon the surface of an overflowing current of water.

My present impression is that these charcoal layers have originated in the decay of aged stems, such as have produced the "pot-stones" and "pot-holes" common in our coal-mines. The wood and the greater portion of the bark would accumulate, in a fragmentary state, within the hollow cylinders of the less easily destroyed bast-layer of the bark of such stems, until some recurring flood converted the damp ground into a temporary shallow lake, filling all these cylinders with water, when all such fragments would speedily float out, leaving the empty cylinders to be occupied by the sands and clays by which they are almost always permanently filled. The displaced vegetable fragments would swim freely for a time, diffused widely over the surface of the waters, but, as the latter subsided, they would settle down upon the layers of more completely disorganised vegetable soil, which, being already damp and soddened, would be likely to remain undisturbed by the temporary and sluggish currents that would exist where a forest-covered swamp was thus overflowed.

Prof. Green appears to balance very fairly the respective measures in which reproductive spores and the merely vegetative portions of the Carboniferous plants have contributed their quota to the carbonaceous mass. At the same time, much more work remains to be done before our theories on this subject can be regarded as wholly satisfactory.

The chief point in Prof. Green's work which I should be disposed to criticise is his map representing the probable distribution of sea and land during the carboniferous age. We are so ignorant of the extent to which denudation has affected vast geographical areas, that all such attempts appear to be inevitably hypothetical. At the same time Prof. Green's reasonings on the subject are extremely plausible and ingenious.

The third chapter of the volume is devoted to the coal plants—especially to the two types of Calamites and Lepidodendron, with the near relative of the latter, the Sigillaria. Since this portion of the volume is avowedly based upon my own memoirs, criticism of any kind would be out of place here. I would only observe that Prof. Miall appears to have reproduced my notions, be they right or wrong, with great accuracy. I may, however, observe here that one of the points for which I have so long contended, in opposition to my French friends, viz., the close identity of Asterophyllites and Sphenophylla, has just received unanswerable confirmation. Herr von Stur *has obtained both these types of foliage upon one single plant*, the former being the ordinary vegetative foliage, and the latter the whorls of leaves belonging to the fruiting branches.

In the fourth chapter we find Prof. Miall upon his own ground. In it he deals with the animals of the coal-measures, to the history of many of which he has made such valuable contributions. The chapter affords a rich illustration of the progress which the animal palæontology of the coal-measures has made during the last half century. Within that period Dr. Hibbert first called attention to the large teeth and bones of the Burdie-house limestone. It was only in the third decade of the century that we began to find scanty fragments of similar objects in the Ardwick limestones of Manchester, and it was at a yet later period that the Wigan Cannel was found to be rich in remains of similar objects. How changed this portion of our knowledge now is the reader of Prof. Miall's interesting chapter will readily learn. Prof. Miall wisely explodes the baseless notion of an atmosphere ladened with a superabundance of carbonic acid—existing during the Carboniferous age—a notion which still reappears in some geological works, but which rests upon no probable foundation. On the other hand he very correctly shows the importance of studying the fishes of the Carboniferous rocks when attempting to classify these rocks by the light of their animal remains. He points out the rarity of the Carboniferous Ganoids in the mountain limestone contrasted with the comparative abundance of the Elasmobranchs—a statement which every geologist familiar with these rocks will readily confirm, and he shows also how difficult it is to determine between the several influences of marine and fresh-waters in producing the Carboniferous beds. At the same time, fully admitting the correctness of Prof. Miall's statement that the Ganoids become proportionately more numerous as we ascend from the limestone to the newer beds, the Elasmobranchs in the upper coals of Lancashire and Yorkshire are far more numerous than in any known estuarian or fresh-waters at the present day, and consequently they place a great difficulty in the way of our regarding the upper Carboniferous, sedimentary deposits as being absolutely due to fresh water. Prof. Miall admits that his conclusions on this point compel us to admit "the supposition that the Elasmobranchs were more largely fluviatile than in any other periods." On the other hand, seeing how largely the noble ganoids of the Permian, Liassic, and Cretaceous ages were undoubtedly marine, it may be as readily contended that the Carboniferous Ganoids were marine as that their Elasmobranch companions were fresh-water.

In the fifth and sixth chapters the chemistry of coal is dealt with. For this portion of the work I presume we are wholly indebted to Prof. Thorpe and his auxiliaries in his Leeds laboratory. This portion of the work is of high interest. Dr. Thorpe has made numerous new analyses, and amongst other matters he has endeavoured to throw further light upon the question first raised by Prof. Huxley, viz., the true influence of Lycopodeaceous spores in producing the bituminous portions of the coal. But though Prof. Thorpe's researches into this question are highly interesting, the problem is far from solved; hence I believe he proposes to carry out a further series of analyses, in the hope of throwing further light upon this obscure but important subject. Space does not admit of my referring to the numerous other chemical aspects of coal which Prof. Thorpe so carefully records.

The four remaining chapters deal respectively with coal as a source of warmth, a source of power, and with what is commonly called the coal question; in the *two* latter chapters, ground gone over by Prof. Jevons, some years ago, is again traversed by Prof. Marshall. To attempt to criticise these latter chapters would be presumptuous on my part, still I cannot quite accept Prof. Marshall's conclusions that what he calls "physical

waste" in contradistinction to "commercial waste," should be allowed to go on. If his argument is a sound one, a tenant is justified in only getting such coal as is *most* cheaply obtained, and in leaving buried in the bowels of the earth, unattainable by future generations, valuable material merely because the getting of it would involve more cost than would attend the raising of coal from thicker and more cheaply workable seams. When a tenant rents *all* the coals under a given acreage of ground his interest in the property is temporary and limited. It is therefore to his interest to raise only such coal as can be most cheaply raised in the shortest space of time. It is not necessary that the raising of the coal which he thus abandons should involve an actual loss to the tenant. It is enough for the argument that he would have to raise it at a diminished profit, which he will certainly not do if he is permitted to devote the same time and labour to such coal as will leave him more profit. Of course freedom of trade and labour suggest that a man should be allowed to pursue the course most profitable to himself, but seeing the vital importance of our coal supply to our existence as a manufacturing nation, it does appear to me that the coal-raiser should be prevented by the lord of the manor primarily—or, if he fails to do his duty, by the legislature—from thus wasting the chief instrument in the production of our national wealth—even if such interference involved some reduction of his profits, or of some addition to the price of coal.

I need not say more to show the interesting character of the contents of this unpretending volume. It is most creditable to its authors, and I shall be much surprised if its merits do not meet with a wide recognition.

W. C. WILLIAMSON

ASCENSION

Six Months in Ascension; an Unscientific Account of a Scientific Expedition. By Mrs. Gill. (London: John Murray, 1878.)

THOSE who know anything of Ascension will wonder how on earth any one could find sufficient material during even a six months' stay to write a volume of 300 pages upon it. We doubt if any one but a lady circumstanced as Mrs. Gill was could have made a readable story out of the barren materials to be found on this land-ship of an island, as it really is, to all intents and purposes; and she has managed to write a thoroughly interesting narrative. If every scientific worker were as fortunate as Mr. Gill in having so sympathetic a companion and coadjutor to tell all the circumstances of his work, the world might think a great deal more of those apparently dry figures and easily-expressed results, which seem to have no touch of nature about them. To those who see only the scientific side of the matter, it may seem a very simple and very pleasant thing to watch the stars night after night; let such read Mrs. Gill's book, and perhaps they will have more sympathy and perhaps a little pity for astronomers sent on scientific expeditions to remote islands.

Mr. Gill, as many of our readers will remember, spent the last six months of 1877 on the Island of Ascension for the purpose of observing Mars in opposition, an opportunity occurring then such as would not occur again during the century. Lord Lindsay lent his celebrated heliometer, the Astronomical Society granted 500*l*., and the Admiralty did all in their power to make Mr. Gill's sojourn on Ascension as pleasant and successful as possible. In an introductory chapter Mr. Gill gives an exceedingly interesting sketch of the principal previous attempts which have been made to measure the distance of the sun, and the results that have been come to with regard to that hitherto rather inconstant "constant." The perusal of this chapter will not only be instructive to the general reader, but must greatly increase the interest of the subsequent narrative, showing as it does the important results that depended on the success of the expedition, the human side of which is so graphically described by Mrs. Gill. She herself gives a brief but very successful explanation, in popular language, of how the sun's distance is measured.

As outgoing vessels seldom touch at Ascension, the expedition, consisting of Mr. and Mrs. Gill, with their heavy baggage, were detained for some time at St. Helena, a detention which both seem to have enjoyed. Mr. Gill succeeded in finding what he, with considerable probability, surmises to have been the site of the observatory used by Halley, in 1677, to observe the transit of Mercury, and make his catalogue of southern stars. They of course saw all the lions of the island, and Mrs. Gill's descriptions are so clear and fresh that even those who have read much about St. Helena will find in them much to interest. Even when Ascension was reached, it was no easy matter to land through the great "rollers" which are so characteristic a feature of some Atlantic islands. We hear a good deal about these puzzling phenomena, which are so difficult to account for, but which Mrs. Gill is inclined to think are probably due to the cause suggested by Capt. Evans. That keen-sighted hydrographer thinks these rollers are probably the far-reaching result of the breaking-up of the continents of ice in the Antarctic regions, miles and miles of which break off, and, plunging into the sea, give rise to huge submarine waves, whose strength is not expended even when they reach Ascension and St. Helena. Mrs. Gill's description of life in Ascension, and especially of the life of the "expedition," is given with a good-natured and graphic pencil. At first the observatory was established on an admirable piece of ground at George Town (or "Garrison," as it is called on the island), on the West Coast, where a very nice cottage was allotted to the astronomer and his wife. Her housekeeping difficulties are amusing enough to read of, though at first awkward enough to one unaccustomed to garrison or rather naval life. Ascension is to all intents and purposes one of her Majesty's ships at anchor, and everything is conducted exactly as on shipboard. All food and drink are served out at fixed time as rations, and as supplies are at all times limited, there is ample room for economical management, and little room for luxury and extravagance. The new-comers soon became accustomed to the routine of the land-ship, and after a day or two got comfortably settled in their cottage, and had the heliometer and other instruments most satisfactorily located on their solid asphalte floor. But, unfortunately, this happy state of things was not without a cloud—a real genuine cloud—which threatened to frustrate the great object of the voyage and all the preparations. This

cloud persistently hung over the island and prevented anything like satisfactory observation, and had it not been for Mrs. Gill's pluck, failure might have been the result. It occurred both to her and her husband that the cloud was only local, and to prove the truth of this suggestion, Mrs. Gill undertook a journey along the coast, starting about midnight, over great cinders and deep rifts, to a point almost four miles south. The supposition proved true, and amid many difficulties the observatory was dismounted, and the instruments removed to the south-west of the island, to a small inlet christened Mars Bay, in memory of the expedition. But what a change from "Commodore's Cottage," as the "Garrison" residence was called. Ascension is an extinct volcano, and it is now little more than a huge mound of cinders and dust. On such floor did Mr. Gill pitch his tent, and on such a base had he to erect his delicate instruments. The discomforts attending his surroundings knocked him completely up, but with the help of Mrs. Gill and the doctor he was set on his feet again, and by the ministry and companionship of the former the encampment was made tolerable. Fortunately after all these hardships and trials and doubts as to weather, the observations at the critical time were completely successful, as were a long series of subsequent comparison observations. The captain of the island and his subordinate officers deserve the greatest credit for the assistance and support which they gave to the enthusiastic astronomer and his ever-helpful and cheerful wife. After the real work of the expedition was completed Mr. and Mrs. Gill made several excursions over the tiny island, and with the exception of an oasis on the summit of the "mountain," the island seems dreary in the extreme, and Mrs. Gill failed to find the neat square gardens and paved streets seen by Sir Wyville Thomson. Altogether, on a very unpromising subject, she has succeeded in writing a really interesting and instructive book, telling us much about the islet and its inhabitants, and still more about the circumstances under which an important piece of scientific work was done. We strongly recommend it to the perusal of our readers.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Schwendler's Testing Instructions for Telegraph Lines

In the absence of my friend Mr. Schwendler in India, perhaps I may be allowed to offer a few remarks on the notice of his book on line-testing which appeared in NATURE, vol. xix. p. 192.

It must be remembered that the book is primarily intended for the use of the officers of the Indian Telegraph Department, and that the conditions in that country differ very much from those in England. Here the overland lines are in such positions that any accident happening to them may be easily detected, but in India the lines run in many parts through countries with few inhabitants, and the distances between stations is sometimes very great. Formerly when a breakdown or fault occurred, the line-riders were sent out from the stations to find out what was the matter, and Mr. Schwendler gave a very amusing account of two of these natives riding out from the two ends of the line to find a fault, meeting in the middle, salaaming and asking one another if anything wrong had been seen. On receiving a negative reply they salaamed and rode back, but the line was none the better for it. It must be, to say the least, tedious to ride many miles over a rough country staring at a wire on an Indian sky on the chance of finding a dead snake across the wires or a bird's nest on an insulator. These difficulties suggested the very systematic line-testing now in vogue in India.

It is unfortunate that the reviewer has shown such a disrespect for mathematical formulæ. There is no doubt that the book swarms with them, but it is by means of these that Mr. Schwendler has discovered many of the facts stated in the book, some of which your contributor seems to doubt. I will, with your permission, instance two cases. He writes, "Indeed it is very doubtful whether his proof that the sensibility of the bridge method is greatest when the branch and the resistance are equal is true. At any rate in our practice we find that the more delicate the galvanometer of the bridge the more sensitive and the more accurate is our test."

In the last sentence it is not quite clear what the reviewer means by a "delicate" galvanometer. I do not know that Mr. Schwendler says that the galvanometer should not be delicate, but he does say that its resistance should bear a certain relation to the resistance measured. For a high resistance a galvanometer of high resistance should be used, and for a low resistance one of a proportionately low resistance. But the alteration of the resistance should not be made by using only a portion of the coils. This is fully explained on p. 22, where it is shown that the coils should be connected either consecutively or parallel in order to increase or diminish the resistance of the instrument. Thus all the convolutions of the galvanometer are used, but as the resistance is diminished in the second case a larger flow of electricity takes place and a greater deflection is produced. The results of these theoretical considerations are so readily tested by experiment that it is surprising that the author of the notice should have thrown doubt on their accuracy. I have therefore thought that it might be useful to make some measurements which have fully confirmed the theory. I will not trouble you with all the experimental numbers of about 160 measurements, which would be as "appalling" to the readers of NATURE as Mr. Schwendler's formulæ are to the writer of the review. A reflecting galvanometer with two coils was used. Connected consecutively their resistance was 5590 units and parallel 1405. The results would have been more striking if the coils had been of unequal resistance so that the parallel resistance would have been less, or if the two halves of the bobbins could have been connected parallel, which would have reduced the resistance to about 700 units. The following table will show the results obtained on measuring three resistances with varying branch resistances, and with the two arrangements of the galvanometer the deflections of which were noted when a certain alteration of the comparison coil was made :—

Resistance tested. Units.	No. of cells used.	Resistance of branches. Units.	Alteration of comparison coil. Units.	Deflection of spot of light with galvanometer coils: Consecutive.	Parallel.
4740	20	10	20	14	15
—	—	100	—	91	95
—	—	1000	—	192	190
760	20	10	4	23	39
—	—	100	—	140	234
—	—	1000	—	333	386
90	1	10	2	47	93
—	—	100	—	77	148
—	—	1000	—	77	121

These numbers show that the branches should approximate to the resistance measured and also that the galvanometer resistance should be smaller when a small resistance is measured. Calculation shows that the most advantageous resistances of the galvanometer in the three cases would be 2870, 880, and 95 respectively.

There is another point with regard to testing with Wheatstone's Bridge, which is not noticed in the review, but to which I may be allowed to direct attention;—that is, the position of the galvanometer. It is not indifferent in which diagonal of the bridge the battery and galvanometer are placed when the branches are unequal. In such a case the method is much more delicate when the galvanometer is placed in the diagonal joining the junction of the two largest resistances with the junction of the two smallest. As, I believe, we have in this laboratory the only Wheatstone's bridge yet constructed after Mr. Schwendler's design, by which the position of the galvanometer and battery can be altered by the shifting of four plugs, I have made a few tests which will show the advantage of this arrangement.

The diagonal joining the junction of the branches with the junction of the comparison coil and the resistance measured is called *m n*; the other diagonal being *p q*.

Resistance measured. Units.	No. of cells used.	Resistance of branches. Units.	Alteration of comparison coil. Units.	Deflection of galvanometer in diagonal	
				m n	*p q*
		$\frac{b}{a}$			
90	1	$\frac{100}{100}$	2	148	147
—	—	$\frac{100}{1000}$	20	53	122
—	—	$\frac{10}{1000}$	200	$7\frac{1}{2}$	$34\frac{1}{2}$

It will thus be seen that when the branch resistances are equal it is indifferent in which diagonals the galvanometer and battery are placed; but this is not the case when branch *a* is greater than branch *b*. It is hardly necessary to observe that in a practical test more than one cell would be used when the branches are unequal, in order to obtain much larger deflections, and more accurate measurements.

HERBERT McLEOD

Royal Indian Engineering College, Cooper's Hill, January 6

The Unseen Universe—Paradoxical Philosophy

THE principle of continuity forbids us to imagine that the collocation called the atom has existed as it is from all eternity. This the authors of the "Unseen Universe" have insisted upon, and I need not go further than their title-page to remind Mr. Hallowes that in like manner they do not contemplate a future eternal existence for the atom.

But this principle cannot tell us what was the exact nature of the thinkable antecedent of the present universe, nor can it tell us the exact nature of that state which will follow the disappearance of the present system. There are, however *strong scientific analogies* which lead us to believe that the thinkable antecedent of the present system was a spiritual unseen, which not only developed but which now sustains the present order.

Is it therefore necessary that I myself should in like manner help to sustain some inferior universe? I repudiate any such obligation. I am not fit for it.

Because a little boy has a father, is it logically essential that he should likewise have a son?

HERMANN STOFFKRAFT

Schloss Ehrenberg, Baden, January 11

Molecular Vibrations

IN NATURE, vol. xix. p. 158, col. 2, is the following:—

"It has been suggested that the same molecule may be capable of vibrating in different ways, and thus of yielding different spectra, *just as a bell may give out different notes when struck in different ways*." It is well to note that the bell as a whole gives but one sound, and the other sounds are not true harmonics, but come from parts of the bell, either before the whole is in vibration or from parts badly amalgamated, flaws in the metal, air-bubbles in pouring into the mould, lack of homogeneity, inequalities in the mould, &c.

The noises in a belfry are most discordant, whereas harmonics form a succession of consonances—octave, fifth, fourth, major and minor thirds, seventh and treble octave.

WM. CHAPPELL

The Electric Light

WHILE so many experiments are being made on lighting by the incandescence of infusible materials produced by electric currents, it is well to point out that Dr. Draper, as early as 1844, used a strip of platinum so heated to determine the facts that all solid substances become incandescent at 977° F., that light increases in refrangibility and intensity, and that the order of the colours emitted followed the true prismatic order as the temperature increases.

Dr. Draper says: "Among writers on optics it has been a desideratum to obtain an artificial light of standard brilliancy. The preceding experiments furnish an easy means of supplying that want, and give us what might be termed a 'unit lamp.' A surface of platinum of standard dimensions raised to a standard temperature by a voltaic current will always emit a constant light. A strip of that metal one inch long and $\frac{1}{20}$th of an inch wide, connected with a lever by which its expansion might be measured, would yield at 2,000° a light suitable for most purposes. Moreover, it would be very easy to form from it a photometer by screening portions of the shining surface. An ingenious artist would have very little difficulty, by taking advantage of the movements of the lever, in making a self-acting apparatus in which the platinum should be maintained at a uniform temperature, notwithstanding any change taking place in the voltaic current." (*Vide* Draper's "Scientific Memoirs," p. 45.)

Wimbledon, January 11

W. H. PREECE

Force and Energy [1]

III.

IN consequence of energy not being a directed quantity we come at once upon an important distinction between transference of energy and transference of momentum. There may be a large force exerted, *i.e.*, a large amount of momentum rapidly transferred, without there being any accompanying transference of energy. In the distance V on the two sides of a given section of the stressed material through which the two opposite streams are flowing, there is lodged a certain amount of motion which is the same in the one portion on the one side of the section as in that on the other side. The momentum and the energy lodged in each portion are simply different functions of one and the same motion. In unit time the whole of the motion in the portion on the one side of the section is transferred into the portion on the other side, and *vice versâ*. The resulting quantitative transference of the one function of the motion is double what would take place if only one, instead of two, opposite streams were flowing through the section, the reason being that this function is a directed quantity. The resulting quantitative flow of the other function of the motion is zero, because it is a function which has no direction. The rate of transference of momentum, or the force, is in this case eE, the sign being given by the sign of e. Suppose, now, one only of these streams of motion to be flowing past the section, the rate of transference of momentum being $\frac{1}{2}eE$, where e is the geometrical ratio of extension, or the strain. The rate of transference of energy remains to be calculated. The material may be either at rest or in motion. In fact whether it is to be considered at rest, or at what velocity it is to be considered moving, depends altogether upon the set of bodies relatively to which the motion is to be measured. Its relative velocity may also be either uniform or variable. The relative velocity of the centre of inertia of the material lying between two given sections will be uniform if the whole of the motion measured in any quantitative way flowing in through one of these sections is equal to that simultaneously flowing out at the other.

Suppose that before the force begins to act there is a uniform velocity, v_0, throughout a given length. As soon as there is a uniform force, $\frac{1}{2}eE$, throughout this whole length, the flow being only in one direction, one half the particles will have at any instant the velocity, v_0, while the other half has the velocity $(v_0 + v)$, where $v = e\sqrt{\frac{E}{\mu}}$.

$V = \sqrt{\frac{E}{\mu}}$ being the velocity of stream-flow; there is in the length V lodged an amount of momentum $(V\mu v_0 + \frac{1}{2}V\mu v)$ for unit section throughout that length. Of this amount $\frac{1}{2}V\mu v = \frac{1}{2}eE$ is transmitted forwards per unit of time. The mean velocity of the material is also $(v_0 + \frac{1}{2}v)$.

[1] Continued from p. 219

The amount of kinetic energy lodged in this length measured relatively to the same set of bodies as v_0 relates to, is

$$\left\{\tfrac{1}{2} \cdot \tfrac{1}{2} V\mu \cdot v_0^2 + \tfrac{1}{2} \cdot \tfrac{1}{2} V\mu \cdot (v_0 + v)^2\right\},$$

of which there is transmitted forwards per unit of time the amount

$$\tfrac{1}{2} \cdot \tfrac{1}{2} V\mu\left\{(v_0 + v)^2 - v_0^2\right\} = \tfrac{1}{2} V\mu v\left\{v_0 + \tfrac{1}{2} v\right\} = \tfrac{1}{2} e E\left\{v_0 + \tfrac{1}{2} v\right\}.$$

This is equal to the force multiplied by the mean velocity of the material. The truth of this last proposition is quite independent of which group of bodies the velocities are measured relatively to. The energy transferred is to be measured relatively to the same group as that to which the mean velocity of the material is measured. But the expression for the rate of transference of energy consists of two parts, only one of which varies with the choice of axes of velocity-measurement. Thus the acting-force $= \frac{1}{2} e E =$ rate of transference of momentum; the mean velocity of the material $= v_0 + \frac{1}{2} e \sqrt{\frac{E}{\mu}}$; and the rate of transference of energy $= \frac{1}{2} e E \left\{ v_0 + \frac{1}{2} e \sqrt{\frac{E}{\mu}} \right\} =$ rate of doing work. The sign of the last rate indicates simply in which direction energy is flowing. The sign depends on that of the mean velocity and on that of e. Here e is a linear strain, and must have the sign $+$ or $-$. If it is a twist it should have the sign $\sqrt{-1}$ or $-\sqrt{-1}$.

The constant part of the energy transferred—that part independent of the axis of reference—is $\frac{1}{4} e^2 E \sqrt{\frac{E}{\mu}}$. This and the amount of the acting force cannot be altered in any way by varying the choice of axes. This result at first sight seems somewhat contradictory to the notion that energy is a thing of infinitely greater objective reality than force is. The amount of the momentum of a body's visible motion and the amount of its energy can be made just as great or as small as we please, by simply imagining one or other group of bodies to be at rest. In this way its momentum may be made to vary at will from $-$ infinity to $+$ infinity, while its energy may be made to vary from zero to $+$ infinity. Etymologically the words "force," "momentum," and "energy" are mere names, but the first, force, has objective reality in the sense that it is related only to the fundamental units of mass, space, and time, and does not depend at all upon an arbitrary choice of axes; while the second and third, momentum and energy, are simply products of the imagination.

The first of these statements, viz., that respecting the physical reality of force in the sense above explained, may be objected to because of the appearance of velocities in the expression for it $\frac{1}{2} e E = \frac{1}{2} V\mu v$. But here the first velocity $- V$ is the length of material passed through by a wave of longitudinal momentum in unit time, and it is an experimental fact that this is quite independent of the velocity of the material measured relatively to no matter what set of axes. The second velocity v is double the mean velocity of the material after the force has begun to act, measured relatively to a set of axes, relatively to which the material was at rest before the force began to act. Thus, v may be looked upon as containing in itself the definition of the axes relatively to which it is to be measured, and thus its magnitude is not at all at the disposal of our imagination.

Similarly the rate of transference of energy measured relatively to a set of axes with respect to which the material was at rest before the energy began to be transferred, is absolute in the sense that we cannot arbitrarily alter its magnitude by an exercise of the imagination.

We have in the above supposed a single stream of motion flowing continuously onwards and through the material under consideration, so that that material neither gained nor lost on the whole momentum or energy. If the portion of material considered does not pass on the whole motion it receives, but retains either a part or the whole of it, its rate of gain of energy is to be found by applying the above equations to its one or two or more surfaces, or surface layers, through which transfers of energy are going on. If it is receiving energy only through one surface and losing it through no surface, its rate of gain of energy is $\frac{1}{2} e \mathrm{E} \left\{v_0 + \frac{1}{2} v\right\}$, where e is the strain at the receiving surface, and $(v_0 + \frac{1}{2} v)$ the velocity of that surface, measured in the proper directions. It is to be observed that new finite increments of velocity gradually spread over the whole material, so that each small part is accelerated by fits and starts, and the whole mass is accelerated by what might be called pulsations, or, in the case of the strains being shearing ones, in a sort of wriggling fashion. The surface particles have at any instant the velocity v_0, say. They instantaneously gain the velocity v and immediately afterwards lose it again, and experience this change a great many times for an interval during which their time-average velocity is $(v_0 + \frac{1}{2} v)$. After this interval they for another equally long interval alternate between the velocities $(v_0 + v)$ and $(v_0 + 2 v)$ in such a way that their time average velocity is $(v_0 + 1\frac{1}{2} v)$.

The gain of energy in one unit of time is in magnitude evidently dependent on v_0: that is, on the axes of reference arbitrarily chosen. Thus, not only can we alter the magnitude of the energy resident in a body arbitrarily by choosing different sets of axes, but, by a simple exercise of the imagination, we can set the energy possessed by any portion of the universe increasing at any arbitrarily desired time-rate. The momentum may be imagined what we like, but we cannot exercise our imagination upon its rate of transference, or force; on the other hand, both the amount at any time and the rate of transference of energy we may make what we please. This last, however, does not at all invalidate the conservation of energy as a proposition concerning the energy measured relatively to a given set of axes; because, although the time-rate of gain of energy of one portion of the collection of bodies investigated may be increased by changing from one set of axes to another, still that change creates simultaneously a correspondingly increased rate of loss of energy in another part, namely, that other part from which the energy is being transferred to the former.

It is to be observed that this change arbitrarily accomplished in the magnitude of rate of exchange of energy is only possible if a force is acting. If no force is acting, e is zero, and the rate of exchange of energy is zero, whatever v_0 be.

This mathematical possibility of altering, by a change of motion-axes, the time-rate of gain of energy of any special portion of the system, seems to me to furnish the strongest conceivable argument in favour of there being existent no other kind of energy except that of motion, *i.e.*, kinetic energy, represented algebraically by the formula $\frac{1}{2} \mathrm{MV}^2$. If the conservation of energy is true in any sense which will include kinetic energy as part of the energy which is conserved, and if the rate of transference of energy from one part of the system to another can be altered by arbitrary changes of the velocities effected by choosing different axes, then there can be no energy that is not energy of relative velocity.

Comparing the kinds of reality to be ascribed to "force and to "energy," we see that while force has quantitative definiteness quite independent of the stand-point arbitrarily assumed by the physical imagination in viewing them, it lacks that kind of reality which some believe to be an attribute of those things only which are "conserved," because force comes into existence and goes out of it again. This kind of reality may be more or less aptly illustrated by supposing that the personality of a human being be not immortal but to come into existence either gradually or suddenly with the birth of the human being, and to go out of existence with its death. If this were the case, and if the results of the temporary existence of this human being were always to live in the subsequent history of human phenomena, then force would have very much the same sort of reality as the personality of a human being. On the other hand, the quantity of energy that exists depends on this standpoint of the imagination, but so long as this standpoint is unchanged there is no change in the amount of the energy. In other words it is "conserved." So long as the position from which it is viewed is not shifted energy can neither be created nor destroyed. To make for energy an illustration somewhat parallel to the above made for force, suppose that all mankind had agreed upon a certain unit of goodness, and that the Deity was a thing the amount of whose goodness, measured by this unit, was really dependent upon the characters of the philosophies believed in by different sets of men, or upon the characters of the men themselves, then the beneficence of the Deity would be constant so long as the philosophic stand-point from which he was considered remained the same, and would have no other kind of constancy. If this were the case then energy would have very much the same kind of reality as the Deity. Again, momentum is conserved in the same way as energy. Also, force being the rate of transference of momentum, the real existence of force implies also the real existence of motion, of which energy is

simply one of various possible algebraic function; that is, of which energy is one of various possible quantitative measures, and of which momentum is another such measure. But although the reality of force implies the reality of energy and of momentum, the absolute quantitative definitiveness of force does not imply any corresponding quantitative definiteness of energy or of momentum. Now physics is distinguished from metaphysics by being essentially quantitative. It appears, then, that force is a physical reality independent of relation to axes of reference, and that energy and momentum become physical realities only when they are referred to such axes, because when not so referred, they have no quantitative definiteness. They remain, however, when not referred to axes, what may be called non-quantitative realities, and probably many people would choose to call them on that account metaphysical realities.

In conclusion I may offer one remark not strictly bearing upon the subject of this letter, which is the proper PHYSICAL use of the words force and energy, but which was suggested during an explanation of the above definition of force to a friend. There are some minds so constituted that they cannot get on at all without continually referring to metaphysical ideas. This fact should make those whose minds are not so constituted unwilling to believe, as they are very apt to do, that metaphysics is only an unreal, improper, and injurious phantasy or disease of the brain. If there are two such real sciences as metaphysics and physics, in the first place it is clearly advantageous to avoid confusion of the two as far as possible, and we may hope to be able keep them separate from the top down to the base where they rest together, or one upon the other. If there are certain words which it is very convenient to use in both these sciences and with accuracy, it is clear that they must have different definitions, *i.e.*, different meanings in the two. But it would be unfortunate if there were no correspondence between the two meanings. If the two sciences are realities they must consist in two different methods of assimilating as part of our knowledge the same facts; and the statements of the one science ought to be capable of definite translation into the language of the other. And this ought to be held in view in arranging the nomenclature of the two. Now I think that the strictly physical definition of force I have given, viz., the time-rate of transference of momentum, has a true correspondence with the ordinarily accepted metaphysical idea of force as "the cause of the change of velocity in masses." Metaphysically the cause of the acceleration of momentum of the one body is the transference of momentum from the other body, and this transference is also the cause of the retardation of momentum of the other. In the physical definition quantitative accuracy is obtained by introducing the idea of the "time-rate." In a metaphysical definition quantitative accuracy is neither possible nor is it desired, the inherent difference between metaphysics and physics being that the latter is quantitative while the former is not so. The friend to whom I threw out this hint objected that I was here only going one step further back, and that the question became "what was the cause of the transference of momentum?" It was evidently he who had made the step backwards, and of course it was a metaphysical step, not objectionable in itself, but having no bearing on the matter in hand. The above question is no objection to the metaphysical statement or definition, that the cause of the acceleration of momentum is the transference of momentum. If metaphysics is fit to do anything at all it ought to be able to investigate the cause of a cause; but even if it were not able to follow the chain of causes beyond any certain point, that would not constitute any objection to the statements of causative sequence made in following along the chain to the possible limit. The metaphysical answer to the question, "What is the cause of transference of momentum?" would probably be different according to the circumstances of the transference, whether it were by impact or by gravitation, or otherwise. To show, however, that my physical definition of force has a true correspondence to the metaphysical idea, it is quite unnecessary to answer this question, it is unnecessary to go beyond the cause which is called "force" in metaphysics.

ROBERT H. SMITH

Absorption of Water by the Leaves of Plants

I FEEL sure that many of your practical readers will be pleased with the article in NATURE, vol. xix. p. 183, on the "Absorption of Water by the Leaves of Plants," as a correction of a fallacy long held by many physiological botanists in antagonism to the experience of plain observers of nature.

In reference to the concluding remark on the statements of Prof. Calderon, the following may perhaps be interesting.

Every botanist who visits my Sewage Farm is struck with the luxuriance not only of the cultivated crops, but with that of weeds found growing, out of reach of the hoe, on hedge-banks and places whence it is impossible for their roots to reach the fertilising stream, which readily accounts for the growth of the crops.

It seems clear, therefore, that plants can absorb nitrogenous organic matter which may be wafted over their leaves by winds from a sewage-irrigated field, and I welcomed Mr. Darwin's account of insectivorous plants as a confirmation of my theory; but, after all, no one has ever doubted the power of absorbing carbon through leaves since van Helmont's celebrated experiment with the willow, and it can hardly be unnatural to credit plant-life with the power of obtaining another element of nutrition by the same channel.

ALFRED S. JONES

Havod-y-wern Farm, Wrexham

The Formation of Mountains

I HAVE deferred replying to Mr. Fisher's letter (NATURE, vol. xix. p. 172) till I had an opportunity of looking at Maxwell's "Theory of Heat;" but, having done so, I am no wiser, for I do not find the point in dispute anywhere referred to. In the "English Cyclopædia," art. "Heat," I find, however, the following statement: "If we suppose the mass of the earth to have been at any remote period at a very high temperature, the effect of the radiation of its heat through the colder surrounding space would be, to cool first the superficial strata, and successively, *though in a less degree*, the internal strata." This slower cooling of the internal parts of a heated mass seems a necessary result of the "law of exchanges," to which the supposed "more rapid cooling of the interior of the globe than the crust" seems as decidedly opposed.

Mr. Fisher's illustration certainly shows how the centre *might* cool more rapidly than the outside, if heat were not subject to laws, and could set the law of exchanges at defiance. He says: "As the people disperse they move off the more quickly the further they get from the dense mass." This would be true for heat, and exactly corresponds to the quotation given above from the "English Cyclopædia;" but it is inconsistent with Mr. Fisher's statement a little further on, that the numbers in an outer belt "may continue about the same, while those in the central crowd become fewer and fewer." The two things are contradictory; and I still fail to see how the "more rapid cooling of the interior of the earth," limited as it must be to that superficial layer within which the effects of solar heat are confined, can be held to furnish a *vera causa* for the compression and contortion of deeply seated rocks and their upheaval into mountain chains.

ALFRED R. WALLACE

Musical Notes from Outflow of Water

EVERY one is familiar with the sounds produced by water running out through a pipe from the bottom of a vessel, when the water-level has got low. The other evening I witnessed a phenomenon of this order, which has, I think, certain interesting features. Desiring to empty my cistern, and the pipes being frozen, I rigged up a gutta-percha tube siphonwise, and brought the water through it. When the orifice of the tube in the cistern got partially uncovered by the descending water-level, a series of rhythmical vibrations was generated, giving a musical note. The plane of the orifice was about vertical; but notes may be had when it is at any inclination with the horizontal water-surface. The intensity of the notes depends, I believe, partly on the difference of level of the vessels; but I cannot furnish exact data as to this, or the way the pitch is affected by various influences (width of pipe, &c.). Would some one proffer an explanation of the "mechanism" or essential character of the phenomenon?

M.

Shakespeare's Colour-Names

MR. BREWIN's assertion that Shakespeare's "word was doubtless *keen*" (not *green*) in the passage ("so green, so quick, so fair an eye") in "Romeo and Juliet," iii. 5, may be put on a par with his "wonder that the correction was not made long

ago." That alteration was made by Sir Thomas Hanmer, and has been rejected by every subsequent editor, and rightly so. "Green" was a common epithet for the eyes, and examples occur in many of our early poets, from Chaucer to Milton. Dyce quotes from H. Weber (*à propos* of Cervantes), "Green eyes were considered as peculiarly beautiful." We have of Neptune, "Thy rare green eye," in "The Two Noble Kinsmen," v. 1, in a passage attributed by some to Shakespeare. That Shakespeare wrote *green* in "Romeo and Juliet" I think beyond reasonable doubt; and if he wrote *green* he certainly meant *green*, and not *blue*: for in "A Midsummer Night's Dream" green eyes are compared to leeks. In our day violet eyes have the precedence over green eyes, yet I think there is still a kind of fascination in the latter. I leave the eagles to the naturalists. *Ne sutor, &c.*

C. M. INGLEBY

Valentines, Ilford

OUR ASTRONOMICAL COLUMN

A VARIABLE STAR OBSERVED BY SCHEINER IN 1612.—In the last number of the "Vierteljahrsschrift der astronomischen Gesellschaft," Prof. Winnecke examines an observation made by Scheiner, of *Rosa Ursina* notoriety, which appears to involve for its explanation the variability of a star at a past time which of late years has exhibited no fluctuation in brightness. In Scheiner's second work, "De Maculis Solaribus," published at Augsburg in 1612, are several letters addressed to his patron, Welser, one of which, dated April 14, 1612, contains observations of Jupiter and his satellites from March 29 to April 8. (It will be remembered that Scheiner regarded the solar spots as in reality solar satellites, which explains the introduction of notices of the satellites of Jupiter in a work professedly relating to sun-spots.) On March 30 he remarked, in addition to the four known satellites of the planet, a fifth star in the same field of view, not observed on the preceding night. This star diminished to invisibility on April 9. Suspecting a slight proper motion, it was regarded by Scheiner as a *fifth satellite* of Jupiter. From figures showing the position of the star with respect to the planet on March 30 and April 7, it may be inferred that they were in conjunction in longitude on the latter day, with a difference of latitude of 10′, the star to the south. Some years since Prof. Winnecke had calculated the place of Jupiter from Bouvard's table for the date of observation, with the view to identify the star which so soon disappeared, but Leverrier's tables for this planet being now available, he engaged Herr Küstner, one of the students at Strasburg, to compute the position of Jupiter for April 7, 1612, at Paris midnight: the geocentric longitude was found to be 136° 13′ 4″·3, and the latitude + 1° 6′ 52″·7 (differing about 6′ from Bouvard's place); hence the position of Scheiner's star, referred to the epoch of the "Durchmusterung"—1855·0, will be in R.A. 9h. 29m. 21·2s., Decl. + 15° 52′·1, thus identifying the object with a star of 8·5m., which the "Durchmusterung" places in R.A. 9h. 29m. 21·4s., Decl. + 15° 53′·5. There are several observations of this star; it occurs in Lalande's zone, 1796, April 4 (No. 18886 of the reduced catalogue), as 8m.; Bessel observed it twice in 1825, estimating it, on February 24, 8m., and on March 12, 7·8m., and Struve using it as a reference-star for Biela's comet on October 26 in the following year, also rated it 7·8m. Again, it was observed by Preuss with the Dorpat meridian circle, in March, 1833, and noted of the same magnitude, so that during this period its brightness appears to have been constant, and Prof. Winnecke adds that repeated comparisons made by himself during the last seventeen years have not indicated any variation. The close agreement of place identifies the star satisfactorily, and he infers that we have here an instance of a star which, though apparently constant during the present century, was variable in Scheiner's time. Prof. Winnecke remarks upon the interest that would attach to a spectroscopic examination of this object by the possessors of powerful telescopes. Its position for 1880·0 is in R.A. 9h. 30m. 44s., N.P.D. 74° 12′·7. He considers that, notwithstanding Scheiner's inexpressible prolixity, the author of the *Rosa Ursina* does not deserve the severe reproach which he has received at the hands of the astronomical historian, but that he was thoroughly candid in communicating what he had seen, and much acquaintance with his writings has strengthened this opinion.

The unusual phenomenon to which we have adverted appears to have made a strong impression upon Scheiner, who transmitted his observation on the instant to Welser.

THE ZODIACAL LIGHT.—We have already alluded in this column to the very questionable accuracy of a statement so often made in popular astronomical works, that the evening zodiacal light is best seen in these latitudes in March, near the vernal equinox, the inclination of its axis to the horizon being then greater than earlier in the year. Notwithstanding this circumstance, it appears certain that of late years the finest views, or we would say the most conspicuous exhibitions of the zodiacal light have occurred between the middle of January and the middle of February. Many instances of bright displays of the phenomenon during this interval might be mentioned. Thus, on February 6, 1856, Secchi records that the light at Rome was brighter than he ever remembered to have seen it, and of great extent; it was yellowish towards the axis, and while the more conspicuous part of the Via Lactea, in Cygnus, was invisible in a hazy sky at a low altitude, the light was traceable to the horizon; it was slightly curved towards the north, and is described as presenting on the whole "un grande spettacolo;" on this evening, it is added, the rest of the sky was illuminated in an unusual manner. Again, it was in the middle of February, 1866, that Mr. Lassell, during his last residence at Malta, witnessed a remarkable display. He says as he went up to the Observatory the striking brightness of the zodiacal light riveted his attention as never before. It was at least twice as bright as the brightest part of the Milky Way, and fully twice as bright as he ever saw it before, and Mr. Lassell upon this occasion also remarked that its character was quite different to that of the Milky Way, a difference more easily recognised than described; generally it is of a much redder hue. In 1874, in the neighbourhood of London, the most conspicuous displays took place on the evenings of January 14 and 17, and February 18, and in 1875, on January 24, 25, and 30, on the first of these evenings the zodiacal light was surprisingly conspicuous, decidedly reddish, and much excelling any part of the Milky Way. Observations on the position of the apex during these favourable views of late years fully support the conclusion of Prof. Julius Schmidt in his treatise on the phenomenon, published in 1856, that the maximum eastern elongation of the apex falls about the middle of January. Towards the end of March, on the contrary, there is a minimum, according to the Athens astronomer, as regards elongation, breadth, and the inclination of the axis of the light on the north side of the ecliptic.

BIOLOGICAL NOTES

NEW ASIATIC FISHES.—In the *Annals of Natural History* for 1873[1] was given a translation of Prof. Kessler's description of the new sturgeon, *Scaphirhynchus fedtschenkoi*, recently discovered in the Syr Daria or Jaxartes, and a note by Dr. Günther, pointing out the interest attaching to the existence in Northern Asia of a second species of this curious form, hitherto only known from the single species, *S. cataphractus*, of the Mississippi. Recently, however, a second Asiatic species of *Sca-*

[1] "On a Remarkable Fish of the Family of Sturgeons," &c. (*Ann. Nat. Hist.*, ser. 4, vol. xi. p. 269).

phirhynchus has been discovered in the Amou Daria or Oxus by Modest Bogdanoff, and named after the well-known governor of Turkestan, *S. kaufmanni.* This new fish was first described and figured in a Russian work on the Natural History of Khiva, prepared under General Kaufmann's directions some time since, but not yet published—owing, we may well suppose, to General Kaufmann's time being too much taken up with other more important matters. Figures and descriptions of it are given in Prof. Kessler's great work upon the results of the Aralo-Caspian Expedition. The fourth part of this work, published in January, 1877, contains not only full details as to this species, but also of a third Asiatic species of this genus—*S. hermanni*, Severzoff, likewise from the Oxus, without caudal filaments, which, however, is only based upon young examples. As already remarked by Dr. Günther in the note above referred to, the presence in the great Asiatic, as well as in the North American rivers, of this and another peculiar form of the limited group of sturgeons[1] is one of the highest importance in zoological geography. There can be little doubt that species of the genus *Scaphirhynchus* will also be found to occur in the great Chinese rivers, the Yang-tzé-kiang and Ho-ang-ho.

RESPIRATION OF AMIA.—*Amia calva* is a fresh-water fish of the United States. It is abundant in the Mississippi and its tributaries and in the great lakes. It attains a length of about two feet. Mr. Burt G. Wilder has published (*Proceedings* of the American Association for the Advancement of Science, 1877) an account of a series of experiments, which seem very conclusively to show that Amia not only exhales but also inhales air, and that this respiration is carried on by means of its swim (air) bladder. This is so much subdivided, that it will be remembered that Cuvier and others compared it to the lung of some reptiles. Experiments seem to show that the aerial respiration was more active when the water in which the fish lay was imperfectly aerated. The average of twenty-three measurements of the amount exhaled was thirteen cubic centimetres. The exhaled air contained about three per cent. of carbonic acid, and when the fish was fasting it contained at least one per cent. Amia displays great powers of endurance of privation of water. On one occasion a specimen was kept out of water for an hour and five minutes without any apparent discomfort or injury. During most of the time the gill-covers were tightly closed, but there were regular movements of the jaw, hyoid apparatus, and sides of the mouth.

CHILIAN BUTTERFLIES.—We have received a monograph of the butterflies of Chili, by Edwyn C. Reed, printed at the national press at Santiago de Chile. It contains descriptions of some sixty-six species, several of which are described as new, and the monograph is accompanied by three plates. We hope that we may from time to time be able to announce further new contributions to the natural history of this district, so well known by the elaborate "Historia fisica y politica" of Gay.

INSECTS IN TERTIARY ROCKS.—Mr. S. H. Scudder has recently published an account of some very remarkable forms of insects from the tertiary rocks of Colorado and Wyoming. These descriptions form Article xxiv. of the forthcoming vol. iv. of the United States Geological and Geographical Survey. Perhaps the most generally interesting insect described is a fossil butterfly (*Prodryas persephone*), which was found so perfect as to allow of the description even of the scales of the body and wings. It is the first butterfly fossil found in America, and, as only some nine species are known from the well-worked tertiary strata of Europe, it is undoubtedly of great value and interest. It shows a marked divergence from living types. A beetle is described (*Parolamia rudis*) which is rather of an Old World than of a New World type. A fly (*Palembolus florigerus*) is interesting not only as representing a highly-specialised type hitherto unknown in America, but as showing how the semblance of an original vein may be formed in a wing out of mere fragments of distinct veins. Masses of eggs of a species of Corydalites are also described as the first insect eggs found in a fossil state.

ON THE RELATIONS OF RHABDOPLEURA.—Prof. Allman believes that the very anomalous characters of this curious polyzoon genus (*Rhabdopleura*) admit of being derived from the typical confirmation of a polyzoon by certain easily understood modifications. One of the most puzzling of those characters is the apparent absence of a tentacular sheath. He maintains that the endocyst is really represented by the contractile cord which seems to take the place of the funiculus in the fresh-water polyzoa, but with which it has nothing to do. In *Rhabdopleura* the endocyst has receded from the ectocyst, and in its posterior part of the approximation of its walls, and the consequent nearly complete obliteration of its cavity has become changed into the contractile cord. Anteriorly, it spreads over the alimentary canal of the polypide, to which it becomes closely adherent, and here represents the tentacular sheath. Still more posteriorily the endocyst undergoes even greater modification, for the contractile cord becomes chitinised and converted into the firm rod which is found running through the stem and branches of the older parts of the colony, and which still presents in its narrow lumen a trace of the original cavity of the endocyst. The shield-like appendage which is attached to the lophophore is one of the most remarkable features in the genus. G. O. Sars regards it as representing the epistome of the Phylactolæmatous polyzoa, but this view is entirely opposed by the history of its development. Prof. Allman, by tracing its development in connection with that of the polypide has arrived at the conclusion that it is formed as a primary bud from the modified endocyst, and that in its turn it gives origin to a bud of the second order, which becomes directly developed into the definite polypide. The primary or scutiform bud continues for some time to increase in size with the developing polypide which it considerably exceeds, but is at last surpassed by the latter. It never disappears, however, but ultimately remains in the condition of a subordinate appendage of the polypide to which it had given origin. We have thus in the life-history of *Rhabdopleura* an alteration of heteromorphic zooids. The first term, however, in the genetic series, the direct product of the sexual system is as yet wanting, no trace of this system having hitherto been discovered in *Rhabdopleura* (Linnean Society of December 19, 1878).

[1] Of the Sturime genus *Polyodon*, or Shovel-nosed Sturgeons, one, *P. folium*, occurs in the Mississippi, and a second, *P. gladius*, in the Yang-tzé-kiang.

GEOGRAPHICAL NOTES

M. BRAZZA and Dr. Ballay, the two Ogowé explorers, have arrived in Paris. M. Brazza is now preparing a map showing his discoveries in West Africa. It shows that the Ogowé issues from a large chain of mountains, and is formed by a number of rivulets descending from the high regions. The explorers suppose that a large part of the water filling the bed of the Ogowé issues by subterranean infiltrations from the Congo Basin. MM. Brazza and Ballay are led to this conclusion by the belief that the Congo is to be found on the other side of the range of mountains mentioned. They were unable to make a direct verification of this assumption, on account of the hostility evinced by the native tribes, who are of the most warlike disposition. It was with the utmost difficulty that the French explorers escaped from the hands of these barbarians, whose war-cries, arms, and canoes present striking resemblances to the ferocious

blacks fought by Stanley. The Central Section of the Paris Geographical Society has decided to give to MM. Brazza and Ballay the great gold medal for 1879. Some members proposed to give it to Nordenskjöld, but the prolongation of his voyage, owing to his detention in Behring's Straits, was considered sufficient reason to adjourn Nordenskjöld's claims to 1880.

MANY proposals have been made for a new initial meridian to be adopted by all nations, but no satisfactory solution has yet been reached. The present state of things is very confusing, with nearly as many different initial meridians as there are civilised countries. In *L'Exploration* M. de Beaumont proposes the adoption of a zero passing through Behring's Straits and down the Pacific, its antemeridian passing through the centre of Europe and Africa; but, indeed, any universally-adopted zero would be better than the present confusion.

THE capitalists of Liverpool and Manchester, finding so many of the old markets shut against their enterprise, propose making a railway 500 miles long, from Zanzibar to the south end of Victoria Nyanza, to develop the trade of Central Africa. In the speeches on the subject at Manchester great ignorance was shown of the geography and hydrography of the region in question, and if only a desire to develop the resources of Africa is at the bottom of the movement, it is quite unnecessary to spend a million of money on a railway. With the magnificent water-way explored by Stanley and other travellers, and with the help of either Indian or tamed African elephants, the resources of Central Africa could be quite adequately developed for many years to come.

IN the January number of Petermann's *Mittheilungen* Dr. Gerhard Rohlfs gives the results of his search, during his last journey in the Libyan Desert, for the supposed empty river-bed of the "Bihâr-Bilâ-mâ." He discusses the chief references to this supposed extinct river, and concludes from his researches that there is no warrant for placing its dried-up bed on our maps. The same number contains a fine map of the region about the sources of the Oxus, with short explanatory text by Dr. Behm, and a map of North Siberia, showing Nordenskjöld's track from the Yenessei to the Lena. Accompanying the latter are German translations of the letters of various members of the expedition.

A CONTRACT has been concluded by M. Sibiriakoff, of Irkutsk, in Siberia, with the firm of Kockum, whereby the latter are to build him a steamer of 350 tons burden, for the purpose of going to the assistance of the *Vega*. It is expected that the steamer will be ready soon enough to start, fully equipped with provisions, in time to reach Behring's Straits, by way of the Suez Canal, next August, in order to assist Prof. Nordenskjöld and his companions. The vessel will afterwards trade to the Lena, and, if possible, even to the Yenessei.

AN Italian traveller, Manzoni, made a journey of some importance in Yemen, Arabia, in 1877, the results of which appeared in the *Esploratore*. In June last Manzoni commenced a second journey from Aden northwards to Asir and eastwards to Hadramaut. After visiting several places of interest he arrived in Sana, where, according to last reports, we learn from Dr. Behm's summary, he was ill. This exploration is supported by the Italian *Cosmos*.

THE last number of the *Isvestia* of the Russian Geographical Society contains an important paper by M. Maieff, giving an account of his journey last summer to South Bokhara. M. Maieff describes the various *beckdoms* or subdivisions of Bokhara, their productions, trade, and people, their chief physical features and hydrography. He concludes by some important information on the various routes from Guzar to the Amu Daria and Afghanistan.

A LETTER received from M. Oshanin, from Turkestan, announces that he has just returned from his great journey to Karataghin. He has discovered a very fine glacier, which he has called by the name of the late Fedchenko. This is the third locality bearing the name of the traveller: M. Ujfalvy has called the Lake Kutban-kul "Lake Fedchenko," and M. Maieff has given the same name to one of the peaks of Ghissar.

THE GEOLOGICAL HISTORY OF THE COLORADO RIVER AND PLATEAUS[1]

FOR convenience of geological discussion, Prof. Powell has divided that belt of country which lies between Denver and the Pacific, and between the 34th and 43rd parallels, into provinces, each of which, so far as known, possesses structural and topographical features which distinguish it from the others. The easternmost he has named the Park Province. It is characterised by lofty mountain ranges, consisting of granitoid and metamorphic rocks pushed upward and protruded through sedimentary strata, the latter being turned upwards upon the flanks of the ranges and their edges truncated by erosion. The generalised transverse section, on the assumption that the sedimentaries, prior to uplifting, were continuous across the mountains, is that of a broad and extensive anticlinal, sometimes profoundly-faulted parallel to the trend, the sedimentary strata which may once have extended across being removed by erosion. The intervening valleys still retain the entire sedimentary series. This form of mountain structure, with its resulting topographical features, gradually passes, as we go westward, into another type, arising from the decreasing frequency of the greater displacements or differential vertical movements of the earth's surface; but most frequently the dislocation is a combined monoclinal and a fault, or series of faults, with all shades of relative emphasis. The small departure from horizontality amid great general displacement is a strong trait, and justifies the name which has been applied to it by all observers with one accord—the PLATEAU COUNTRY.

West of this province lies a third one—the Great Basin. It is characterised by short, jagged mountain ridges, separated by goodly intervals of barren plains. These ridges are usually produced by the up-lifting of the strata along one side of a fault. Sometimes the faults are multiple, that is, consist of a series of parallel faults, the intervening blocks being careened in the same manner and in the same direction. This repetitive faulting is of very common occurrence. Other modifications, and even different types of structure, are presented; but there is throughout the Great Basin a striking predominance of monoclinal ridges, in which one side of a range slopes with the dip of the strata, and the other side slopes across their upturned edges. The forms impressed upon these masses by erosion are rugged, bristling, and sierra-like, and their peculiarities are aggravated by the fact that before these mountains were brought forth the platform of the country from which they arose had been plicated and the plications planed down by erosion. The Basin is the oldest western land of extensive area. Its final emergence was not later than Jurassic, and may have a still older date.

Between the Plateau and Park Provinces there is no definite boundary. Gradually as we proceed westward from the Parks of Colorado the valleys widen out and expand into a medley of terraces, bounded by cliffs, which stretch their tortuous courses across the land in every direction, yet not without system. The boundary separating the Plateau Province from the Great Basin, on the contrary, is abrupt. In many parts of its extent it seems almost possible to hurl a stone from one province to the

[1] By Capt. C. E. Dutton, U.S. Army, Assistant-Geologist U.S. Survey o the Rocky Mountain Region, under Prof. J. W. Powell, in charge.

other. Still there is a border country where the plateaux take on a type of structure which suggests the Basin type, though never to be confounded with it. Powell has given it the name of Kaibab structure, and through it the Grand Cañon of the Colorado cuts transversely. This structure extends northward from the Grand Cañon more than 250 miles, reaching within 100 miles of the Uintas, or even nearer than that. Between the great faults tabular masses have been uplifted to the average altitude of 11,000 feet, with grand valleys between them.

To the eastward of these high plateaus is spread out a wonderful region. Standing upon the eastern verge of any one of these, where the altitude is nearly 11,500 feet, the eye ranges over a vast expanse of nearly level terraces bounded by cliffs of strange aspect (Fig. 1). They wind about in all directions, here throwing out a great promontory, there receding in a deep bay, but continuing on and on until they sink below the horizon, or swing behind some loftier mass, or fade out in the distant haze. Very wonderful, too, is the sculpture of these majestic walls.

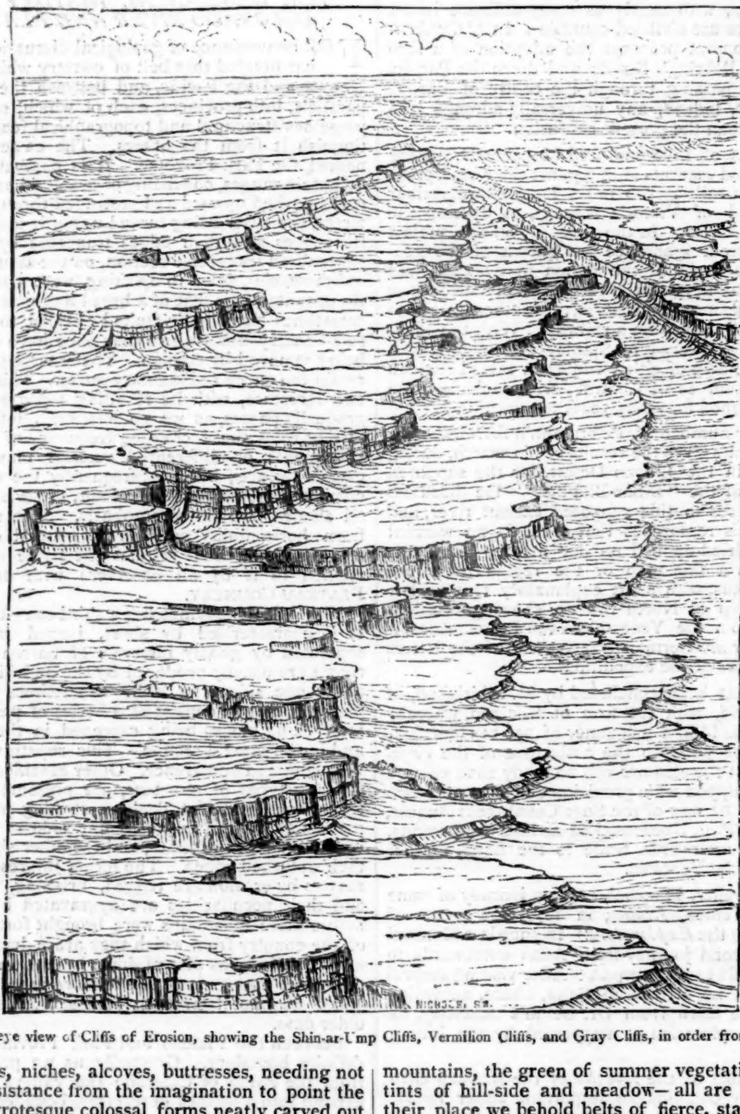

FIG. 1.—Bird's-eye view of Cliffs of Erosion, showing the Shin-ar-Ump Cliffs, Vermilion Cliffs, and Gray Cliffs, in order from Right to Left.

Panels, pilasters, niches, alcoves, buttresses, needing not the slightest assistance from the imagination to point the resemblance—grotesque colossal forms neatly carved out of solid rock, endless repetitions of shapes, which pique the fancy to find analogies, are presented to us on every hand, and fill us with wonder as we pass. But of all the characters of this unparalleled scenery, that which appeals most strongly to the eye is the colouring. The gentle tints of an eastern landscape, the rich blue of distant mountains, the green of summer vegetation, the subdued tints of hill-side and meadow—all are wanting, and in their place we behold belts of fierce, staring red, yellow, and toned white, which are intensified rather than alleviated by alternating belts of dark iron-gray. The Plateau Country is the land of cañons. Gorges, ravines, cañadas, are found in every high country, but cañons belong to the region of plateaus. Like every other river the Colorado has many tributaries, and in former times

had many more than now; and every branch and every twig of a stream here runs in a cañon. The land is honey-combed with them. To cross it, except in certain specified ways, is a feat reserved exclusively to creatures endowed with wings. The region is a desert of the most formidable description. A few attenuated streams

FIG. 2.—Grand Cañon of the Colorado (6,200 feet deep).

meander through it, but usually in cañons of which the bottoms are somewhere between the earth's surface and centre. The springs will not average one to a thousand square miles. But in the High Plateaus, at levels above 7,500 feet, we find a moist climate, exuberant vegetation, and hundreds of sparkling streams.

During Cretaceous times, the Plateau Country was a marine area. After 4,000 feet of Cretaceous strata were

deposited, a large portion, and perhaps the whole of this region became, for a time, land, and the uplifting was attended by considerable dislocation and flexing of the strata. In numerous localities the Cretaceous strata are seen to be denuded, and the lowest Tertiary beds lie across the bevelled edges. This uplifting took place after the deposition of a group of beds which in part, at least, are the equivalents of those which King and Hayden have named the Laramie Group. I accept the verdict of Marsh, Meek, King, and Powell, that these beds belong to the local Cretaceous series, and reject the decision of Hayden, that they are Tertiary. Thus the close of the Cretaceous is marked by a physical break separating it from the local Tertiary series by widely distributed unconformities.

After an unknown interval of denudation immediately following the close of the Cretaceous period the region was again submerged, and then began the deposition of that remarkable series of Eocene beds which form such a striking feature in the stratigraphy of the peripheral parts of the Plateau Country. Around the southern flanks of the Uintas their aggregate thickness exceeds 4,000 feet, but south-westward the upper members at length disappear, and seventy miles north of the Grand Cañon only the lower portion of the local Eocene (the Bitter Creek of Powell or Vermilion Creek of King) remain; indeed, in the latter locality no later beds than the Bitter Creek were deposited. The evidence is now conclusive that the Bitter Creek series stretched more than a hundred miles across the Plateau Country, covering, doubtless, its entire extent, while the middle and later Eocene covered smaller areas to the northward. Only marginal remnants of these huge deposits now remain. The heart of them has been eroded and swept away. Just at the commencement of the Tertiary periods the Plateau Country was covered with brackish water, having perhaps an analogy to the Baltic or Euxine, but after the accumulation of a few hundred feet of deposits the region became a vast inland lake. Its northern shore was along the base of the Uintas, which had then apparently gained their first elevation. Its north-western shore, by a coincidence which can hardly be accidental, lay along the identical boundary which now sharply separates the Plateau Country from the Great Basin, and the latter was one of the mainlands which furnished the sediments of the lake. From the angle where the Uintas join the Wasatch it is possible to trace this shore line more than 300 miles south-westward into Arizona with certainty, and to point out its principal bays and headlands, and even to locate the sites of some of the ancient river channels through which the lower Eocene sediments were brought down. The eastern, south-eastern, and southern margins, and the remainder of the south-western margin, remain to be determined by future exploration. At length, after one-third to one-half of the lacustrine beds had been laid down, there began a series of events which has developed the physical features of the Plateau Country, and which has pursued an unbroken course to the present time, and which even yet may not have culminated. Then began that uplifting which has raised the Plateau Country more than 13,000 feet on an average. Then, too, began a marvellous erosion which has cut down the mean level about one-half that amount, leaving the present mean altitude nearly 6,500 feet. At the inception of this process the lake began to dry up, the south-western portion now drained by the Lower Colorado being the first to emerge. Gradually through the succeeding periods the lake contracted its area, withdrawing northward to the Uinta Mountains, where, at the close of the Eocene, it disappeared.

We are now in a position to trace the origin, growth, and history of the Colorado River, if not from the beginning, at least from an epoch near its beginning. Its creation was not the event of one epoch, but a gradual process extending through several periods. The lower course, extending from the mouth of the Virgin to the Pacific, is the oldest portion, and makes its appearance in geological history a little before, but very near, the middle Eocene. Whether it existed before this epoch is not beyond doubt, but probably it did. But earlier than the Tertiary periods it cannot go; for it is certain that up to the close of Cretaceous times the ocean flowed over its track. When the Plateau Country was first isolated from the ocean it became a brackish Euxine, and may be presumed to have had a Hellespont somewhere. It soon after became an inland lake and must have had a St. Lawrence to keep its waters fresh. There can be little doubt that in the middle Eocene the outlet was the lower course of the Colorado. Whether the lake prior to that had some other outlet which it abandoned for this one is an open question, with the probabilities (on general principles) in favour of the negative. But the question is of no great importance.

The growth of the Colorado may be illustrated by considering what might happen to the St. Lawrence if the whole region of the Canadian lakes were uplifted two thousand feet. In no great length of time Ontario would be drained by the St. Lawrence, lowering its channel, and that river would become one with the Niagara. The same process would be repeated at Erie, Huron, and Superior, the lakes vanishing and leaving only a great river with many branches. Such was the origin of the Colorado; first a Hellespont, then a St. Lawrence, then a common but rather large river heading in the interior of a continent. Its principal branch, the Green River, cuts through the Uinta mountains by the Flaming Gorge and Cañon of Lodore. A second lake, apparently coeval with the one we have just discussed, lay to the north of that range and poured its waters through these gateways into the southern lake. What other bodies of fresh water may have been connected with either of these it is impossible to say at present.

At the epoch when the desiccation was completed it is not probable that the cañons had any existence, for the indications are that the elevation of the country at the commencement of the Miocene period was not great. Conditions favourable to cañon cutting are highly exceptional, and there is no evidence that this exceptional combination of conditions existed at that time, while there is much evidence that it did not. That the conditions, however, were favourable to a rapid rate of erosion is highly probable. But the forms which it would produce might be more nearly analogous to those which may be observed in eastern Ohio and western Pennsylvania. That the climate was moist and sub-tropical is rendered probable by the vegetable remains found in the surrounding regions, and it is only rational to suppose that such a climate in a moderately elevated region would yield such results as may be seen in countries similarly conditioned. Whether the valleys were broad or narrow, abruptly walled or gently sloped, matters little. It is almost certain that they were not deep. The great cañons which we now see had not even been commenced, although they were foreshadowed, and the train of events which was to produce them at a later period had started into activity.

The history of the Colorado and its drainage system during Miocene time must be spoken of only in general terms. In truth during this great age there is no evidence of the occurrence of any critical event aside from the general process of uplifting and erosion which affected the region as a whole. The vast erosion of this region has swept away so much of its mass that most of the evidence as to the details has vanished with its rocks. But the more important features of the work, its general plan in outline, have left well-marked traces and these can be unravelled. It was a period of slow uplifting, reaching a great amount in the aggregate, and it was also

a period of stupendous erosion. The uplifting however was unequal. The comparatively even floor of the old lake was deformed by broad gentle swells rising a little higher than the general platform. In consequence of their greater altitude these upswellings at once became the objects of special attention from the denuding agents and were wasted more rapidly than lower regions around them. Here were formed centres or short axes from which erosion proceeded radially outwards, and the strata, rising very gently towards them from all directions, were bevelled off. As the erosion progressed so also did the uplifting of these local centres or axes, thus maintaining the maximum erosion at the same localities. It is a most significant fact that the brunt of erosion is directed against the edges of the strata and not against their surfaces, provided the stratification is but little disturbed. Usually such an uplift will have one diameter longer than another, and we may call the greater the major-axis. The strata dissolve away in all directions by the waste of their edges, and after the lapse of long periods the newest or uppermost strata will be found encircling the centre of erosion at a great distance—the next group below will encircle it a little nearer, and so on.

This has been the history of each of the sub-divisions of the Plateau Country. Upon the western and northern sides of the Colorado five of these centres are now easily discerned. By far the largest and probably the oldest is around the Grand Cañon. All these had their inception in Miocene time, though the one around the Grand Cañon may go back into the upper Eocene. The district known as the San Rafael Swell is by far the best suited for study.

If we stand upon the eastern verge of the Wasatch Plateau and look eastward we shall behold one of those sublime spectacles which fill even the calmest observer with awe and amazement. From an altitude of more than 11,000 feet the eye can sweep a semicircle with a radius of nearly seventy miles. It is not the wonder inspired by great mountains, for only two or three peaks of the Henry Mountains are well in view, and these with their noble alpine forms seem as strangely out of place as Westminster Abbey would be among the ruins of Thebes. Nor is it the broad expanse of cheerful plains stretching their mottled surfaces beyond the visible horizon. It is a picture of desolation and decay; of a land dead and rotten with dissolution apparent all over its face. It consists of a series of terraces all inclining upwards towards the east. We stand upon the lower Tertiary rocks and right beneath our feet is a precipice leaping down across the edges of the level strata upon a terrace 1,200 feet below. This cliff stretches away northward gradually swinging eastward, and finally southward, describing a rude semicircle around a centre about forty miles to the eastward. At the foot of this cliff is a terrace about six miles wide of upper Cretaceous beds inclining upwards towards the east very slightly, and at that distance it is cut off by a second great cliff plunging down 1,800 feet upon middle Cretaceous beds. This second cliff describes a smaller semicircle concentric with the first. From the foot of the second cliff the strata again rise through a width of about ten miles and are cut off again by a third series of cliffs as before. There are five of these concentric lines of cliffs. In the centre there is an elliptical area forty miles long and twelve to twenty wide, its major axis being north and south, which is as completely girt about by rocky walls as the valley of Rasselas, but such walls as Dr. Johnson never dreamed of. We have given it the name of the Red Amphitheatre. Yet, if we look back to Eocene time, we shall find that the whole stratigraphic series, up to the Eocene inclusive, covered this amphitheatre. Nearly 10,000 feet have now gone, and the floor is near, or quite, at the summit of the Carboniferous rocks. At present the Amphitheatre is drained by two streams which cut across it and find their way, one into the Green, the other into the Colorado, below the junction of the Grand.

Still more vast is the erosion which has taken place from the vicinity of the Grand Cañon. Here the Carboniferous strata form now the floor of the country, though a few patches of Trias still remain in the vicinity of the river. But the main body of the Triassic rocks stands now fifty miles north of the river, and beyond them, in a series of great terraces, rise the Jurassic, Cretaceous, and Tertiary formations—the latter capped with immense bodies of volcanic rock. The greater part of the erosion was accomplished in Miocene time.

It will be seen that these local uplifts are important in determining the subdivisions of the area and the distribution of the maxima and minima of degradation. We may see here a correspondence which is worthy of close attention. Those areas which have been uplifted most have been most denuded. I have asked myself a hundred times whether we might not turn this statement round, and say that those regions which have suffered the greatest amount of denudation have been elevated most, thereby assuming the removal of the strata as a cause and the uplifting as the effect; whether the removal of such a mighty load as ten thousand feet of strata from an area of ten thousand square miles may not have disturbed the earth's equilibrium of figure, and that the earth, behaving as a *quasi*-plastic body, has reasserted its equilibrium by making good a great part of the loss by drawing upon its whole mass beneath. Few geologists question that great masses of sedimentary deposits displace the earth beneath them and subside. Surely the inverse aspect of the problem is *à priori* equally palpable. That some such process as this has operated in the Plateau Country looks at least very plausible, and, if there could be found independent reasons for believing in its adequacy, the facts certainly bear it out. Yet its application is not without some difficulties, and the explanation is not quite complete. Granting the principle, it will be still difficult to explain how these local uplifts were inaugurated; and we can only refer them to the agency of that mysterious plutonic force which seems to have been always at work, and whose operations constitute the darkest and most momentous problem of dynamical geology. On the whole it seems to me that we are almost driven to appeal to this mysterious agency to at least inaugurate, and perhaps in part to perpetuate, the upward movement, but that we must also recognise the co-operation of that tendency which indubitably exists within the earth to maintain the statical equilibrium of its levels. The only question is, whether that tendency is merely potential or becomes partly kinetic; and this again turns upon the rigidity of the earth. But it is easy to believe that, where the masses involved are so vast as those which have been stripped from the San Rafael Swell, and from the Kaibabs around the Grand Cañon, the rigidity of the earth may become a vanishing quantity.

Let us turn now to a law which forms a most important link in the chain of discussion—a law without a thorough comprehension of which the structural geologist in the Plateau Country would see very little except Sphinxes, but one which, when he has fully saturated his mind with it, will enable him to translate many mysteries. This law may be called the persistence of rivers. It is a very simple one, but its uses are wonderful; indeed those who have found it so invaluable in the Plateau Country often wonder why so little use has been made of it elsewhere. If the study of this region should accomplish nothing more than drawing this principle from its modest retirement and installing it in its rightful place in the logic of geology it will still have accomplished a great result. But the law has its limits, which we cannot overstep with safety.

Of all the changing features of a continent the least changeful are its great rivers. Undoubtedly rivers have

perished and undoubtedly they have shifted parts of their courses somewhat; but on the whole their tenacity of life is wonderful, and the obstinacy with which they sometimes maintain their positions is in powerful contrast with the instability of other topographical features. This characteristic, however, fails at low levels. A river near its mouth may often change its course; but where the country is high enough to enable it once to fasten its grip it will hold it, despite all the changes to which the surface of a continent is ordinarily subject throughout the term of its secular existence. Its stability and persistence will depend usually upon its altitude, or what amounts to the same thing, upon the rapidity of its slope. When that is small we may look for signs of inconstancy. Other conditions might be formulated which could affect it or modify it; but on the whole the fact remains that rivers have a remarkable power of maintaining their positions. It would be difficult to point out an instance where a great river has ever existed under conditions more favourable to longevity and stability of position than those of the Colorado and its principal tributaries. Since the epoch when it commenced to flow it has been situated in a rising area. Its springs and rills have been among the mountains and its slope has throughout its career been continuously though slightly increasing. The relations of its tributaries have in this respect been the same, and indeed the river and its tributaries have been a system and not merely an aggregate, the latter dependent upon and perfectly responsive to the physical conditions of the former. And now we come to the point. The Colorado and its tributaries run to-day just where they ran in the Eocene period. Since that time mountains have risen across their tracks, whose present summits mark less than half their total uplifts; the river has cleft them down to their foundations. The Green River, passing the Pacific Railway, enters the Uintas by the Flaming Gorge, and after reaching the heart of this chain, turns eastward parallel to its axis for thirty miles, and then southward, cutting its way out by the splendid cañon of Lodore. Then following westward along the southern base of the range for five miles, a strange caprice seizes it. Not satisfied with the terrible gash it has inflicted upon this noble chain, it darts at it viciously once more, and entering it, cuts a great horse-shoe cañon more than 2,700 feet deep, and then emerging, goes on its way. Thenceforward, through a tortuous course of more than 300 miles down stream the strata slowly rise—the river almost constantly running against the gentle dip of the beds, cutting through one after another, until its channel is sunk deep in the carboniferous. Further down, near the head of the Marble Cañon, the Kaibab rose up to contest its passage, and a chasm more than 6,200 feet in depth bears witness to the result. It is needless to multiply instances. The entire province is a vast category of instances of drainage channels running counter to the structural slopes of the country. I am unable to recall a single tributary to the right bank of the Colorado which does not somewhere, and generally throughout the greater part of its course, run against the dips. The northern tributaries of the Grand Cañon have their entire courses thus related. If we were to take the sums of the lengths of the river and its right hand affluents, we should find that at least three-fourths of that total length lay where the streams run against the dips.

It is clear, then, that the structural deformations of the region—the faults, flexures, and swells, had nothing to do with determining the present distribution of the drainage. The rivers are where they are in spite of them. As these irregularities rose up, the streams turned neither to the right nor to the left, but cut their way through them in the same old places. The process may be illustrated by a feeble analogy with the saw mill. The river is the saw, the strata are the timber which is fed against it. The saw-log moves while the saw vibrates in its place. The river holds its position almost as rigidly, and the rising strata are dissevered by its ceaseless wear.

What, then, determined the situation of the present drainage channels? The answer is that they were determined by the configuration of the old Eocene lake-bottom at the time the lake was drained. Then surely the water-courses ran in conformity with the surface of the uppermost Tertiary stratum. Soon afterwards that surface began to be deformed by unequal displacement, but the rivers had fastened themselves to their places and refused to be diverted. This, then, is the key which unlocks for the geologist the vestibule of the Plateau Country. The rivers were born with the country itself, they are older than its cliffs and cañons, older than its great erosion—the oldest things in its Tertiary history; nay, they are its history, which we may yet read imperfectly in their cañon walls. The mountains and plateaus are of subsequent origin. They arose athwart the streams only to be cleft asunder to give passage to the waters. The rivers amid all changes have ever successfully maintained their right of way. Such are the uses of the limited theorem of the persistence of rivers.[1] I shall not attempt to suggest how far it may be applicable to other regions, but I am confident that any geologist visiting the Plateau Country will be quickly overwhelmed with the conviction that it is true there.

In this connection it remains to add something to indicate the magnitude of the work accomplished, and the real extent of the obstacles which the Colorado has accomplished in maintaining its existence. In the Colorado itself, the maximum work has been done at the Grand Cañon (Fig. 2). This chasm is 217 miles in length, to which should be added properly the Marble Cañon above, 69 miles long, since the two are continuous, and their separation merely nominal. The average depth of the Grand Cañon is a little more than 5,200 feet—almost exactly one mile. Its maximum depth through the Kaibab Plateau is nearly 6,300 feet, this depth being maintained approximately as the river runs for about fifty miles. Surely it might be thought that to cut such an abyss is work enough in the life of one river however ancient of days. But the summit of the Kaibab is Carboniferous limestone. When the river began to run in this part the whole local Mesozoic and lower Eocene series rested upon the site of this plateau, but have since been swept away together with a part of the Carboniferous rocks. The river has cut through the entire fossiliferous system of strata and now runs 2,000 feet deep in the archæan. The total thickness of the fossiliferous system here is, or rather was, very nearly 17,000 feet. Hence in its lifetime the river has cut through about 19,000 feet of strata. Through the remainder of the Grand Cañon the total cutting has been from 2,000 to 3,000 feet less. As we ascend the river the amount diminishes—not regularly but with local maxima—until we approach the southern base of the Uintas. The principal branch, the Green River, has cut its channel into the quartzites of this range even more deeply than the Colorado in the Kaibab. Yet strangely enough the instant the Green is clear of the mountains it enters a long stretch where the cutting has been practically nothing. The explanation of this contrast will become obvious to the geologist by a mere reference to the fact that where the cutting has been zero the locality has been always at the base level of erosion, and never above it. Only those parts which rise above the base level are cut down.

(*To be continued.*)

[1] Mr. Jukes employed the same principle in explaining some features in the lower courses of the rivers of Ireland. *Quart. Journ.* Geol. Soc. of London, xviii. (1862), 378, quoted in Jukes and Geikie's "Manual of Geology," Third Edition, p. 454. [But the idea may be found in Hutton's great work the "Theory of the Earth," and in Playfair's "Illustrations." See particularly pp. 102 and 350 *et seq.* of the latter work.—Ed.]

THE BRITISH MUSEUM LIBRARY

WHAT sort of reference library can be provided in connection with the natural history collections when they are moved from the British Museum to South Kensington? is a subject now under consideration. It is stated on good authority that, so far as the building arrangements at Kensington go, no provision whatever has been made for library space, and that in the Act passed at the end of last session to enable the trustees to move the collections, a reference library seems to have been entirely overlooked. That Act has, however, been the subject of a resolution by the General Committee of the British Association, requesting the Council to take such steps in the matter as they might deem expedient; and although the resolution had principal reference to the administration of the collections, its force extends equally to such an important matter as a library, should the Council "deem it expedient" to include that subject.

Whatever may be the decision as to what part of the library can be transferred to Kensington, or what ought to be transferred, it is only the works relating to biological studies that will be essential there, and it is only these, therefore, that are likely to be the subject of inquiry. But it might, perhaps, lead to changes of great value to those who use the British Museum Library for the purposes of referring to the literature of science in its other branches as well, if the inquiry could be extended to include the question of the actual state of this literature, which is available for use at the Museum. Whether it should be expected that the national library should contain as complete a collection as possible of scientific publications, or whether those who wish to consult them ought to belong to several of the incorporated learned societies, and use their libraries, is a separate question. When this question is considered, if it has to be considered at all, it must not be forgotten that no one society has anything like a comprehensive collection of scientific works, each society aiming at completeness in its own subjects; that to belong to several societies is not within the means of every student; and that, as one of the advantages of these societies is that members may take books away, no one can be sure of finding on the shelves what they may wish to consult.

But quite apart from such a question as this it would be of great use, with a prospect of effecting changes, to know what is the actual state of the British Museum library as regards scientific literature.

Only those who have had occasion to work at the library can have any idea how incomplete it is in this department, or what a wearisome toil it is, in consequence of the system of cataloguing adopted, to find whether a work they wish to consult is or is not there. If the experiences of those who have had occasion to use the library for such purposes could be collected, the probability is that it would be found that from a third to a half of the works asked for were not obtainable there. This may seem at first sight a very surprising assertion to make, but there is good reason to believe it true. What the Museum does or does not contain can, however, be known only by an inquiry, especially directed to ascertain the facts. A reference to the catalogue, as at present arranged, is quite inadequate to give an answer. The officials themselves could not tell from it what they have and what they have not. For example: suppose a particular volume of the Reports of the United States Geological Survey of the Territories is wanted, a reference to the catalogue will not tell whether it has been received or not. The catalogue simply gives the information that the series is on a particular shelf. If a ticket for the whole series is filled up according to the requirements of the reading-room regulations with the press mark, the title, and Washington, 1873, &c., 4° added, then it will be found when the books are brought to the reader's seat, that only volumes two, six, nine, and ten of the whole series are there. This illustration applies to all publications which are issued in a series either by societies or by government departments. To ascertain, therefore, what is the incompleteness of series of which some numbers find a place in the catalogue, it would be requisite, if a reader undertook such an investigation, to write tickets for every series separately, to have all the numbers brought, and then to make note of the gaps. Such a work is rather the duty of the officials than of readers, but, as already stated, it would require a special inquiry, whether made by readers or by officials, to ascertain what is really the state of the British Museum library as to the literature of science.

It must be borne in mind that an important part, perhaps the most important part, of the literature to which a worker in science wants to refer, is that which is in the series of the different societies and government departments, and it is just in this that the British Museum is weakest, and in which it might be supposed a remedy might be most easily found. To fill up gaps of old standard works out of print is not very easy. Chances of sales of libraries must be carefully looked out for to effect this, but the current literature of societies and of departments is more easily secured.

An inquiry into the state of the scientific literature at the Museum, and the facilities for its use, might be advantageously directed under three distinct heads, each of which has an important bearing on meeting the requirements of those who wish to consult the collection:—

1. As to the incompleteness of series.
2. As to the length of time that elapses between the publication of a number and its being obtainable at the Museum.
3. As to the method of cataloguing.

As regards (1) incompleteness of series, there is no reason to believe that it is confined to publications referring to any particular branches of science more than others. For example, to take a few cases at random, there are only three volumes of the reports of the state of the Brussels Observatory; there is only one part of the long series of reports on the health of the City of London; there are three volumes wanting of the Report of the Commissioners on the Sanitary Condition of the Labouring Population of Great Britain; the publications of the Geological Survey are very incomplete; there are none of the maps of the Water Supply Commission nor of the Coal Commission; and so on. To attempt to give a list of what is known to be wanting would not be of much use for the reason stated above, that nothing short of a full inquiry into the matter could make known what is the real state of affairs. When a question is asked as to why certain volumes are missing, there is always one reply given—the publications of societies, home and foreign, are presented, and cannot be demanded, and as to the publications of Government departments, the Museum has no claim. If they happen to be sent to the Museum they are received, but if not, it would seem that under the existing system there is no help for it.

As regards (2) the length of time before a volume that is sent can be had for reference, it may be safely put at from one to two years. If a question is asked, how it is that such delays occur, a very general answer is that some societies are very irregular in sending their publications, but when such cases as this occur—that at the Museum a reader cannot now have a volume of the *Bulletin* of the Brussels Academy later than 1876, while at another public museum, the Patent Office Library in Southampton Buildings, he can have it up to June in this year—it seems to point rather to some feature in the administration of the Museum as the cause. Many cases of this kind might be quoted if it were required to establish the fact. It is, no doubt, a wise arrangement that novels and magazines that can be seen at any circulating

library should not be available for use at the Museum till a year after publication. But the case is very different with the class of scientific publications now referred to. Of the foreign and colonial publications not many copies of each issue reach this country, and in some cases they can be seen only by the courtesy of an officer of a society that has received a copy. Then, again, not only the amount of interest taken in any particular communication, but sometimes its value, is changed in twelve months. It has been already said that perhaps the question may be raised whether the British Museum is the place to expect to see recent scientific publications, but it would be well if its present state were in any case known.

Then (3) as to the method of cataloguing. The use of the catalogue is of course to enable a reader to find the press mark of the books he wants with the least possible delay. There may be differences of opinion as to the extent to which a catalogue should help a reader, but the facts as regards the British Museum are these. Scientific publications which are not books, magazines, or newspapers, are for the most part grouped under "Academies." The majority of those which do not fall under this head are to be found under the titles of the government departments by which they are issued. In order not to waste time over the catalogue the reader must know certain particulars about the work he wants. If it is issued by a British government department he must know whether it has or not been presented to Parliament. For example, the pathological researches of Dr. Sanderson and Dr. Klein were addressed, through the Local Government Board, to the Lords of the Privy Council; the geological work of the Survey is through the Science and Art Department of the Committee of Council on Education, also under the Privy Council. The pathological researches are, however, presented to Parliament, and the volume containing any particular part of them must be, therefore, looked for under "Parliamentary Papers," while the geological work is not presented to Parliament, and must therefore be looked for under "Great Britain and Ireland—Geological Surveys." In the former case it is requisite to know beforehand in what year the papers were included; in the latter case the memoir to a map may be obtained in this way, but no clue is given as to how to obtain the map itself. (If the press mark for the map is searched for in the map catalogue, cross-references lead to "World—miscellaneous —*see* geographical and geological"). The difficulty of knowing whether a work has or has not been presented to Parliament is sometimes great. For example, some of Mr. Simon's Cholera Reports are included under the Registrar-General's returns and are therefore to be looked for among "Parliamentary Papers;" while the celebrated 1848 Report, which seems somehow not to have been presented, has to be found in the general catalogue under the name Simon, John. This is, of course, quite consistent with the method adopted. As it is with the British so with the foreign publications of departments, it is requisite to know to what department a report is sent. An entomologist may be surprised that to get at some of the United States' publications giving monographs on certain groups, he has to get his press-mark from the catalogue under United States—Department of the Interior—Geological Surveys of the Territories—yet such is the case. And this, too, is quite consistent with the method of cataloguing adopted.

If the work to be consulted is issued by a learned society it will probably be found entered under "Academies." In order to find it in the catalogue the exact title must be known. For example, it is no use to look for a Society of Arts' publication under "Society of Arts." it is requisite to go in the catalogue from "of" to "for" as the full title is "Society for the Promotion," &c. It is also essential to know whether a society has the prefix kaiserliche or kaiserliche-königliche, or königliche, or Imperiale, or Royal, or British, or the title of any nationality or town. It is also requisite to know where the work is published, as the grouping is according to the plan, Academies at so and so. That a reader should first have all this information about a work he wants to consult may be very reasonable, for perhaps the collection at the Museum is too extensive to admit of printing, as the Patent Office library does, a compact and convenient "list of the scientific and other periodicals and transactions of learned societies in the free library."

But it is after a reader has found in the catalogue the title of the society that his real trouble begins. It might reasonably be supposed that the first entry under the name of the society would be the memoirs, transactions, or journal, as the case may be, of the society. That is not the British Museum plan. First are given the press marks of charter, laws, bye-laws, notices of annual meetings, lists of members, and such like things, and page after page has to be turned over to get to the publications of the society. If there are two sets of publications, such as quarto transactions and an octavo journal, these are generally separated by some pages of other references. To take a very familiar case, the memoirs of the French Académie are of course frequently referred to. After the reader has found the right volume of the catalogue containing "Academies at Paris," and has found Académie des Sciences, he will have to look on one page for vols. i. to xi., then, eight pages further on, for vols. xii. to xxiv., and then, further on again, xxv. onwards. It is difficult to imagine what principle is supposed to be followed, or what is gained to a reader by such a plan. If it should happen that the reader does not know that one series of the memoirs contains the communications of members and another series the communications of "Savans Étrangers," he will still have more trouble in obtaining what he wants. Or take an English case. Suppose a reader wishes to refer to an account of a paper communicated to the Ashmolean Society. He will find, under that heading, entries of an account of the Society, old notices of meetings to be held (handbills), rules, &c., but no intimation of whether the Society issues any transactions.

In short, with all the societies, the entries of the regular publications are so mixed up with rules, list of members, bye-laws, &c., that it takes some time, after the right volume and right page have been found, to turn out their press mark. Again, it is not always easy for a reader to know what is classed as an academy and what is not. An account of a communication given before the Royal Institution in Albemarle Street must be sought in the journal catalogued under academies, while one given before the London Institution in Finsbury Circus, though equally a chartered society, must be sought under "London." Or again, how should the records of observations be catalogued? under periodical publications? under academies, or in the general catalogue. The practice differs in different cases.

Were it not for the kind and ready assistance given in cases of need by the reading-room superintendent and his assistants, a reader would be often quite unable to see what he needs.

THE "GRAHAM" LECTURE AND MEDAL

SOME time ago the Chemical Section of the Philosophical Society of Glasgow had under consideration the propriety of raising a fund for the encouragement of original research. The movement soon began to assume practical shape, and in course of time the fund was found to have reached to nearly 300*l.*, the subscribers being chiefly well-known chemical manufacturers and merchants in Glasgow and the west of Scotland. For a time there was

some difference of opinion as to whether the money subscribed should be invested for the purpose of endowing a lectureship or exclusively for the awarding of medals for original research. It was eventually agreed, however, hat two-thirds of the fund should be appropriated for lecture purposes and one-third for medal purposes, and it was likewise determined that the medal should bear the name of the "Graham" Medal; and that one triennial lecture should also be designated the "Graham" Lecture, both lectureship and medal being instituted in commemoration of the eminent services of a former citizen of Glasgow and member of the Philosophical Society, the late Thomas Graham, Master of the Mint, so distinguished for his researches in chemistry and physics.

As the scheme is now in such a complete state that it may be announced to the scientific world, we mention a few facts of interest in regard to it.

Through their president, Mr. James Mactear, of St. Rollox Chemical Works, the Council of the Chemical Section have been successful in obtaining from Her Majesty's Mint a valuable die of Prof. Graham, and the authorities of the Mint have agreed to strike the medal free of charge, the Trust Fund supplying the necessary gold for the purpose. The Council intend to award the medal at not less intervals than three years, in order that time may be allowed for papers to be brought forward of sufficient merit to justify them in making an award. It may be remarked that the medals, of not less value than 10*l.*, is to be awarded for the best original investigation in chemical physics or in pure or applied chemistry, which may be communicated to the Philosophical Society of Glasgow, or the Chemical Section thereof, during the three sessions preceding the award.[1] The Council of the Section will make the award, or it may be made by an equivalent body of local chemists of repute, with power on their part to remit the function to the Professor of Chemistry in University College, London, or to the Professor of Chemistry in the University of Edinburgh. Papers in competition for the "Graham" medal, may, we believe, be offered from any part of the United Kingdom; in other words, authors need not necessarily be members of the Philosophical Society of Glasgow, or of its Chemical Section. Dr. William Ramsay, University Laboratory, Glasgow, the present Secretary of the Section, will be glad to answer all inquiries in regard to the matter.

For the purpose of inaugurating the "Graham" lecture scheme in the most fitting manner possible, the Council of the Section have induced Mr. W. Chandler Roberts, F.R.S., the successor to Prof. Graham, as Chemist to the Mint, and for a long time his chief assistant in carrying out his later investigations, to deliver the first lecture, which is announced for Wednesday, the 22nd inst. Of course it is to be delivered in Glasgow. The subject is to be "Molecular Mobility, or some Forms of Invisible Motion," with special reference, doubtless, to the valuable physico-chemical researches instituted by Graham. It is the intention of the lecturer to exhibit and even to use a good deal of the apparatus employed by Graham, and now the property of Mr. Roberts.

"The fitness of things" in connection with the delivery of the inaugural "Graham" lecture is still further shown in the choice and consent of Mr. James Young, F.R.S., of Kelly, to preside on the occasion. There may be many readers of NATURE to whom it is not known that the gentleman just named was, when a very young man, a student in the evening popular classes conducted by Graham in the Mechanics' Institution and Anderson's College, Glasgow, whom he afterwards faithfully served as lecture assistant, first in Glasgow, and then in the laboratory of St. Thomas's Hospital, London. That he benefited by the scientific teachings of his great master is abundantly evident in the fact that he is himself the founder of one of our greatest chemical industries, namely, the manufacture of paraffin and paraffin oils—in a sense, the creation of the last quarter of a century, but already big with scientific and practical results. His devout respect for Graham's memory has since become almost a passion, and it is but proper that he should "assist" at this further effort to commemorate the great scientific triumphs of his teacher, master, and friend.

JOHN MAYER

[1] This is surely a mistake; why any limit?—ED. NATURE.

NOTES

AT the anniversary meeting of the Imperial Academy of Sciences of St. Petersburg, on December 29, 1878, it was announced that Mr. Hind, F.R.S., superintendent of the *Nautical Almanac*, had been elected a Corresponding Member of the Academy. Besides Mr. Hind there are in the list of Corresponding Members of this great Academy the names of Airy, Darwin, De la Rue, Frankland, Hooker, Huxley, Miller, Owen, Sabine, and Sylvester.

WE trust the subject discussed in our first article this week will meet with the attention it deserves in the proper quarter. It is clear that, by almost every civilised government but our own, the vast importance of meteorological observatories at high altitudes is recognised, and the universal value of weather forecasts is now taken as a matter of course. France has her Pic du Midi and Puy de Dôme, America her magnificently-appointed Pike's Peak, and, as our article shows, other countries in Europe have each one or more of these all-important lofty observatories; but, as usual, we are half-a-century behind. How valuable meteorological observations would be to the nation, on one or more of our loftiest Scotch mountains, any meteorologist can tell, and may be seen clearly enough from the article. We earnestly hope the question will not be allowed to subside, but will be persistently urged in the proper quarter as a matter of national importance. It would not take the price of a new gun to found such an institution as is wanted.

THE telegraph wires of Pic du Midi Observatory have been broken again for a number of days. Some anxiety was felt at Toulouse for the safety of General Nansouty, and a rumour spread that the house had been crushed by an avalanche descending from the rock at the foot of which it has been built for protection against the wind. M. Albert Tissandier was sent to reconnoitre with three mountain guides. On January 9, in the morning, he started from Bagnères. On the 10th, in the evening, he arrived at the observatory, where he found that the rumours spread in the plains were unfounded; General Nansouty was taking his readings. On the following morning M. Tissandier took some drawings, and on the 12th he returned to Bagnères. The telegraphic communications with Puy de Dôme were interrupted on the 11th, at the very time when they were restored with Pic du Midi.

A SUCCESSFUL experiment was made the other night at Liverpool Street station in electric lighting, the particular form used being that known as the "Farmer-Wallace." Several platforms were successfully lighted up, and only one or two minor and easily remediable drawbacks characterised the display. By means of a small electro-magnet on the top of the frame, carrying a clutch, the carbons are kept constantly adjusted, without interference. The gas companies have at last determined to show what they can really do in the way of illumination, and give themselves fair play in any comparison with electric lighting. The Phœnix Company, on Saturday night, lit up a part of Waterloo Bridge Road with gas of increased power, on an increased number of lamps, with special burners, in specially-arranged cages. The result was quite sufficient to

cause discontent with the present inadequate illuminating power of gas in street-lamps. The expense is of course greater, but we doubt if it would be so much as the cost of any satisfactory system of electric lighting; and perhaps, rather than run the risk of being relegated to the category of "lights of other days," the companies may, by a little pressure, be made to see the advisability of supplying better gas at even a cheaper rate than the present.

A NUMBER of friends and colleagues of the late Karl von Littrow, director of the Vienna Observatory, have had a medal struck in his memory, which may be obtained at a moderate cost from the publishing firm of Gerold and Co., Vienna. The face of the medal bears a portrait of von Littrow, and the reverse a view of the new Vienna Observatory.

M. DELESSE has been nominated a member of the Paris Academy of Sciences, in the section of Mineralogy, in place of the late Prof. Delafosse.

M. EDMOND BECQUEREL, who has been appointed vice-president of the Academy of Sciences for 1879, will act as president of the Academy in 1880, according to the constant custom. The president for 1879 is M. Daubrée, the celebrated geologist, who was nominated vice-president last year. M. Daubrée has been nominated president of the Central Section of the Geographical Society of Paris for 1879; M. Delesse, the newly-elected member of the Institute, one of the vice-presidents.

OUR readers will regret to hear that Prof. Clifford's health is still extremely delicate; he sailed for Madeira a few days ago, accompanied by Mrs. Clifford, in the hope that the genial climate would lead to improvement. We trust this hope will be realised.

THE Managers of the Royal Institution of Great Britain have decided that the next Actonian Prize shall be awarded to an essay illustrative of the wisdom and beneficence of the Almighty; the subject being "The Structure and Functions of the Retina in all Classes of Animals, viewed in relation with the Theory of Evolution." The prize is 100 guineas, and will be awarded or withheld as the managers shall think proper. Competitors for the prize are requested to send their essays (with or without their names being affixed) to the Royal Institution, addressed to the Secretary, on or before October 1, 1879. The adjudication will be made by the managers in 1879.

THE widow of Faraday died last Monday week.

IT seems to be acknowledged that the readings taken by the electrical instruments kept at Montsouris Observatory are not sufficient to give an accurate idea of the changes in the tension of the air. During the present period, when almost every fall of snow was observed during the night, the readings of the Montsouris Observatory gave no sign of negative tension. We are in a position to state that a self-registering apparatus would have been kept in operation from the beginning of last year, if it had not been required to send it to the Champ de Mars Exhibition for the instruction of visitors. M. Marie Davy is now engaged in putting into operation this apparatus. It should be stated that in 1873 a scientific delegate having been sent to England by M. Jules Simon, then Minister of Public Instruction, suggested that the self-registering instruments to be established in the French observatories, should be constructed according to the pattern adopted at Kew Observatory, so that comparisons should not be rendered impossible. The remarkable conclusions recorded by Mr. Whipple last week are an indication of the soundness of these suggestions.

THE winter has been so severe in France that the whole of the land on January 11 was transformed into a solid mass of ice, communication by rail, and even intelligence by wire becoming very difficult in the elevated parts of the country. The most extraordinary fall of snow recorded in the period was close to Montargis, where it accumulated to a height of 2 metres on a long narrow band of several kilometres long. In the meanwhile the largest rivers of the land overflowed, owing to the great rains which had been prevailing. The Seine reached an altitude of 6·21 metres at Pont Royal, the Loire was higher than on any year on record at Nantes, where the inundation was a public calamity; the increase of the Garonne and Rhône was only stopped by the freezing of the high lands.

AMONG the papers to be read at the forthcoming meetings of the Society of Arts are the following:—February 26, "Indian Pottery at the Paris Exhibition," by George Birdwood, M.D., C.S.I.; March 5, "The Social Necessity for Popular and Practical Teaching of Sanitary Science," by Joseph J. Pope, M.R.C.S.; March 12, "The Compensation of Time-keepers," by Edward Rigg, M.A.; March 19, "Economical Gardens for Londoners," by W. Mattieu Williams, F.C.S.; March 26, "The Treatment of Iron to Prevent Corrosion" (a second communication), by Prof. Barff, M.A. In the Chemical Section—January 30, "Gas Illumination," by Dr. William Wallace, F.R.S.E. In the Indian Section—January 21, "Quest and Early European Settlement of India," by George Birdwood, M.D., C.S.I.; February 21, "The Trade of Central Asia," by Trelawney Saunders. In the African Section—February 4, "The Opening of the District to the North of Lake Nyassa, with Notes of a Recent Expedition through that country," by H. B. Cotterell; March 18, "Some Remarks upon an Old Map of Africa contained in Janson's Atlas, published at Paris in 1612," by R. Ward; April 1, "The Contact of Civilisation and Barbarism in Africa, Past and Present," by Edward Hutchinson. Cantor Lectures—First Course, on "Mathematical Instruments," by Mr. W. Mattieu Williams. The Second Course will be by Dr. W. H. Corfield, M.A., on "Household Sanitary Arrangements;" it will consist of six lectures, to commence on February 17. The Third Course will be by Mr. W. H. Preece, on "Recent Advances in Telegraphy." A course of two lectures will be given by Dr. B. W. Richardson, M.A., LL.D., F.R.S., on "Some Further Researches in Putrefactive Changes," in continuation and completion of his course of Cantor Lectures given last session.

A NEW application of the electric light has just been made by some German River Steamboat Companies. Experiments made on the steamers plying on the Weser and Elbe Rivers having proved perfectly successful these steamers will henceforth be illuminated by electricity.

THE captain of the steamboat *Chillon*, the Geneva correspondent of the *Times* writes, which was caught in the storm on the morning of January 2, describes in a letter to the local papers a scene which is not witnessed once in a generation. On Lake Leman, between Rivaz and St. Gindolph, the two winds the *föhn* and the *bise*, met twisting the water up into a column nearly 40 feet high and 10 yards in circumference. It was a veritable waterspout, and, after retaining its position for several minutes, took the form of a vapoury cloud and melted away. The meeting of the *föhn* and the *bise* is more common on the Lake of Lucerne than that of Geneva; but wherever it happens it is terribly destructive, sweeping down the tallest forest trees and wrecking every craft smaller than a steamer.

A SLIGHT shock of earthquake was felt on Friday last at 3 A.M. at Cologne and Eschweiler. From Buir two shocks are reported —the one at 3.15 and the other at 7.43. The *Neue Freie Presse* announces a considerable shock of earthquake from Unterdranburg, which occurred on the 11th inst., at 10.8 A.M. The Central Observatory at Vienna reports a powerful shock at 10h. 18m. 15s. on the same day observed at Klagenfurt. It

lasted thirteen seconds, and was followed by three slighter shocks. The direction was from south-east to north-west. A report from Eisenkappel gives the same time. The shock observed at Cologne, it will be remarked, occurred on the 10th inst., a day sooner.

INVALIDS will be glad to learn that, amidst the severe weather, a comparatively mild climate exists in a part of their own country. A bouquet arrived from Glengariff on Saturday, the 11th instant, comprising wallflower, primrose, primula, stocks, chrysanthemum, scarlet geranium, arbutus-berries, and a rose-bud, all picked from an exposed garden. In Madeira—but five days' journey—ripe bananas and custard-apples are hanging on the trees. Many of the gayest flowers are in full bloom.

IT is proposed at the next meeting of Russian naturalists to unite all Russian scientific societies into one large association, with zoological, botanical, and physiological sections which would have branches at all the Universities.

THE admirable work by Mr. William H. Edwards on the "Butterflies of North America" has been continued by the publication of the seventh part of the second series, which, like its predecessors, is illustrated by five quarto plates of interesting species, drawn by Miss Mary Peart, of Philadelphia. It is especially interesting from the number of observations made by the author, and his correspondence upon dimorphism and polymorphism of a number of the lepidoptera.

WE cannot help expressing our regret at the almost total destruction of the Birmingham Central Reference Library, with its irreplaceable special collections. We have had frequent occasion to speak of the reports of the Birmingham system of libraries, one of the best anywhere. The building which has suffered disaster was close by the Midland Institute, which fortunately has escaped.

DURING the past summer discoveries of a very interesting series of fossil forests were made by William H. Holmes, of the Hayden (U.S.) Geological Survey. The fact of the occurrence of abundant fossil wood, and in some places of fossil trunks *in situ*, had been noted by former visitors to the Yellowstone Park, but nothing had been learned of the manner in which the forests had been preserved, neither had their great extent been suspected. It is found that an extensive series of forests have been buried in the sedimentary formations of the volcanic tertiary, especially in the region drained by the East Fork of the Yellowstone. From the bottom to the top of the highest cliffs rows of upright trunks may be seen, weathered out and ranged along the ledges like the columns of a temple. Throughout a long period of subsidence a constant alternation of land and sea seems to have been kept up by the irregular deposition of fragmentary volcanic products, so that numberless forests grew and sank, one after another, beneath the sea. Fully 4,000 feet of the tree-bearing strata were formed before the final upward movement began. These same strata now cap some of the highest ranges of the Rocky Mountains, and cover an area of upward of 10,000 square miles. The silicified trunks are in many cases from twenty to thirty feet high, and fairly rival the giant trees of California in dimensions.

IN the *Colonies and India* we find a note respecting the employment of sheep as beasts of burden. In Eastern Turkistan and Thibet, for instance, borax is borne on the backs of sheep over the mountains to Leh, Kangra, and Rampur on the Sutlej. Borax is found at Rudok, in Changthan, of such excellent quality that only 25 per cent. is lost in the process of refining. The Rudok borax is carried on sheep to Rampur, which travel at the rate of two miles a day; but, notwithstanding the superior quality and the demand for it in Europe, the expenses attending its transport seriously hamper the trade, which, but for the sheep, would hardly exist at all.

THE proportions of some principal constituents of sea-water have recently been determined by Herr Jacobsen, from forty-six samples of water taken from the most different regions and at different depths, during the expedition of the *Gazelle*. With regard to carbonate of lime, he obtains an average of 0·269 parts of it in 10,000 parts of sea-water; the minimum was 0·220 parts, and the maximum 0·312 parts. Such differences he attributes mainly to experimental errors, and draws the simple conclusion (not favourable to some interesting biological and geological speculations) that the proportion of carbonate of lime in sea-water varies but slightly. The influence of extensive separation of the carbonate of lime by organisms and that of extensive local replenishing of the water with the carbonate are speedily equalised by ocean currents and obliterated for analysis. One region of the ocean does not afford better life conditions for lime-secreting animals than another (by containing more carbonate of lime), and among the causes from which most of such animals are found on coasts and at comparatively small depths is not to be reckoned that adduced by J. Davy, that in the open sea the carbonate almost wholly disappears. Nor is there ground for Forchhammer's supposition that those animals must be capable of changing the sulphate of lime into the carbonate. The author found but little variations also in the proportions of chlorine and sulphuric acid (the chlorine was somewhat the more constant). The observations in general point to a rapid mixture of the sea-water of different regions by currents both horizontal and vertical.

A RECENT number of *La Nature* gives the following statistics of education in Germany and France:—Of the 86,177 conscripts enrolled in 1877 in the German army 78,622 had received primary instruction in the German tongue, 5,415 in other tongues, and 2,140 or 2·483 per cent. could neither read nor write. The district of Posen furnished the largest contingent of this last category, 11·20 per cent.; then follow Prussia, Silesia, Pomerania, Westphalia, Hanover, Brandenburg, Sleswig-Holstein, the Rhine provinces, Hesse Nassau, and lastly Hohenzollern, of which all the conscripts had received primary instruction. According to the census of 1876 there are, in France, 4,502,894 children of six to thirteen years of age. The number of primary schools is about 71,547, of which 9,352 are absolutely gratuitous. It is reckoned that there are 624,743 children who do not attend any school.

THE new railway bridge across the Lim fjord in the Danish province of Jütland was opened for traffic on December 15.

HERR SCHAPER, an eminent Berlin sculptor, has just finished the model for a bust of the late Prof. Braun, for many years director of the Berlin Botanical Gardens. The bust will be executed in bronze and will be erected in the gardens upon a granite pedestal of 2 metres height.

WE have received parts 1 and 2 of vol. ii. of the *Transactions* of the Watford Natural History Society, containing several papers which show that the Society continues to do good work among the animals and plants of Hertfordshire.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. Wm. Trent; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. Carroll; a Common Marmoset (*Hapale jacchus*) from South-East Brazil, presented by Mrs. Currey; a Triangular Spotted Dove (*Columba guineæ*) from South Africa, presented by Col. F. C. Hassard, C.B.; a Great Eagle Owl (*Bubo maximus*), European, deposited; a Bar-winged Rail (*Rallina pæcilоptera*) from the Fiji Islands, purchased.

INDO-OCEANIC RACES

TWO papers of considerable interest on the peoples of the Pacific and Indian Islands were read at the last meeting of the Anthropological Institute. The first of these papers, by the Rev. S. J. Whitmee, so long resident in Samoa, was for the purpose of proposing a revised nomenclature of what he calls the Inter-Oceanic races of men. There is much confusion, it is admitted, in the use of geographical and ethnographical names in the Pacific. Polynesia is employed by some for all the intertropical islands eastward of New Guinea. By others it is used for those islands which are east of Fiji, while Melanesia is employed for the southern islands from Fiji westward, and Micronesia for the northern island. Mr. Whitmee proposes that Polynesia should be uniformly employed in the wider signification, and that the different portions be indicated by east, west, and north-west, just as we indicate the parts of a continent.

The term *Inter-Oceanic Races* is used for the people found in Madagascar, Australasia, the Indian Archipelago, Formosa, and Polynesia. In this region there are two classes of people, who may be superficially described as *dark* and *brown*.

The dark people comprise three very distinct races: 1. The Australians, who may bear the name *Australs*; 2. The people found in the Andaman Islands, the interior of the Malacca peninsula, and some portions of the Indian Archipelago, who already have a good name, viz., *Negritos*; 3. The woolly-haired people of Western New Guinea, the Aru, and other islands in the Indian Archipelago, and Western Polynesia. Two names have been used for these—Papuan and Melanesian, and Mr. Whitmee proposes to keep *Papuan* and drop Melanesian. Where these Papuans are somewhat mixed with brown Polynesian blood, they may be conveniently known as sub-Papuan.

The people known as Alfurese in the Indian Archipelago Mr. Whitmee does not regard as a separate people. As used by the Malays, Alfuro appears simply to mean non-Mahommedan and non-Christian—pagan wild men, whether brown or black. Hence Alfuro cannot be used as an ethnic appellation.

The brown people found, from Madagascar, through the Indian Archipelago, in Formosa, in north-west and eastern Polynesia and in New Zealand, Mr. Whitmee regards as having sprung from one stock which had its home in the Indian Archipelago or the Malacca peninsula. For this family he wishes to retain Baron von Humboldt's name, *Malayo-Polynesian*; not because it is the best possible name, but because it is in use and well understood.

There are five branches of this family: 1. Mr. Whitmee believes the first branch which broke off from the parent stock was that which went across the Pacific to Eastern Polynesia and New Zealand. These people probably retain more of the primitive condition of the parent stock than the others, owing to their isolation. But it is almost certain they have to some extent deteriorated from that condition. This race, which does not now possess a satisfactory collective name, he proposes to call *Sawaiôri*: this word being compounded from the following representative names, *Sa*-moa, *Hawai*-i, and Ma-*ori*, following the precedent of the Horsoks of North Thibet, whose name is from *Hor*-pa and *Sok*-pa. 2. A much later migration went westward to Madagascar, and these people bear the appropriate name *Malagasy*. Probably an approximate date of this migration may be fixed by the presence of a few Sanscrit words in the Malagasy language. 3. Mr. Whitmee is unable to express any opinion as to when the *Formosan* migration took place. 4. The latest exodus from the Indian Archipelago was doubtless that which went to north-west Polynesia (Melanesia). For these people he proposes the name *Tárapon*, from Tárawa, in the Gilbert group (used by Mr. Horatio Hall for the language of that archipelago) and Pónape, a representative atoll of the Caroline group. 5. For that branch of the family found still in the Indian Archipelago he proposes to use the generic name *Malayan*. He believes all these people may be included under this term, and that the differences which exist between them may be accounted for by the isolation of some, while others have had a greater mixture of foreign blood, and have been more in contact with external culture and other influences which have changed them since the family has been broken up.

At the eastern end of New Guinea there are mixed people, who may be called *sub-Sawaiôri*, or *sub-Malayan*, as their affinities with one or other of these divisions may hereafter prove to be.

The following table shows in compact form the divisions proposed by Mr. Whitmee:—

Inter-Oceanic Races of Men.	Dark Races— ? Negrito-Polynesians ...	Austral ...	Australia.
		Negrito ...	Andaman Is. Samang, &c.
		Papuan ...	Aru Is. Western New Guinea. Western Polynesia.
	Brown Stock— Malayo-Polynesians ...	Sawaiôri ...	Samoa. Hawaii. New Zealand, &c., &c.
		Malagasy.	Madagascar.
		Formosan.	Formosa.
		Malayan ...	Malays of Sumatra, &c. Javanese, &c., &c.
		Tárapon ...	Caroline Is. Marshall Is. Gilbert Is.

A lively discussion followed, in which Mr. Wallace, Prof. Flower, and Mr. A. H. Keane took part; the two former, while approving of some of Mr. Whitmee's proposed changes, preferred, on the whole, to utilise existing terms. Mr. Keane, in the main, supported Mr. Whitmee's conclusions; indeed, Mr. Whitmee acknowledged his indebtedness to Mr. Keane for several important suggestions contained in his paper.

The second paper, by the Rev. W. G. Lawes, recently returned from a three years' residence at Port Moresby, New Guinea, was an extremely interesting series of ethnological notes on the Motu, Koitapu, and Koiari tribes of New Guinea.

It is extremely important that all statements about New Guinea should be specific as to locality. It is even more important with reference to the people than to the country, the diversities of race and tribe are so numerous. Twenty-five different dialects and languages are spoken, to the writer's knowledge, in the 300 miles of coast extending from Yule Island to China Straits. Port Moresby is the centre of the Motu district, and is in lat. 9° 30′ S. and long. 147° 10′ E. The Motu were fully described by Dr. W. Y. Turner in a paper published in the *Journal* of the Institute, May, 1878. So far as the Motu is concerned Mr. Lawes' paper was simply supplementary.

Great importance is attached among the Motu to the tattooing of the women as a means of enhancing beauty. No importance seems to be attached by them to the pattern. The men are sometimes slightly tattooed, but with them it is a decoration of honour, and shows that the wearer has killed some one.

The taboo system of Polynesia is practised on many occasions and for many purposes.

The spirits of the departed go away to ocean space (their *hades*), and ultimately find their way to the place which is associated in the native mind with plenty and animal enjoyment.

The legend of the Motu respecting the origin of fire is that smoke being seen out to sea, the animals assembled and volunteered to fetch it. The snake, bandicoot, bird, and kangaroo, all started, but came back without it. The dog then went, and succeeded.

The Koitapu are now for the most part to be found living at one end of the Motu villages although preserving their distinctness and separateness. They are also to be found in little groups of a few houses a little way inland, on a hill overlooking the sea all through the Motu district. The typical Koitapu man is slightly darker in colour than the Motu, and the hair is frizzy, not woolly. The principal differences between the Koitapu and Motu are the following:—

Language.—This is essentially different from the Motu and coast tribes. In a vocabulary of 250 words there are only 12 words which have any affinity for coastal or Malayo-Polynesian dialects.

Food and Cooking.—Their bill of fare is more extensive than the Motu, and the mode of cooking different.

Ornaments.—Those different to the Motu are the breastplate and feather head-dress.

Weapons and Manufactures.—The weapons are stone clubs and spears; the bow and arrow is confined to coast tribes. A netted bag and peculiar kind of matting are made by Koitapu, but the knowledge of pottery is confined to coast tribes.

The Koitapu excel in hunting, but the coast tribes are fishermen. The Motu are the conquerors and superior race, but have a superstitious fear of the Koitapu and inland tribes. The

Koitapu are supposed to have power to bewitch and cause disease, also to prevent rain from falling.

The Motu take presents to Koitapu in case of disease, and the women sometimes suck the seat of pain in the same manner as described in Sir J. Lubbock's "Origin of Civilisation," pp. 27, 28. There are many indications that the Koitapu are now but a small remnant of what was once a numerous and powerful race.

The Koiari are closely allied to the Koitapu, and inhabit the mountains at the back of the Motu and Koitapu district. They consist of a number of scattered tribes. They are physically inferior to the Motu and Koitapu, but more numerous. They are small in stature, dark in colour, and dirty in person. Their hands and feet are remarkably small. Their villages are built on the ridge of a hill. Tree houses are common, almost every village having one at a considerable height. Their language is similar to Koitapu. They cultivate the soil carefully, and are great hunters. The women are more degraded than among the Koitapu or Motu, and polygamy is more common.

The dead are laid out for some weeks in the house, and then exposed to sun and smoke until perfectly dry. When the bones fall apart they are collected and tied up in a bundle and hung up in the deserted house or in a tree close by.

The mode of salutation among the Koiari is peculiar. They salute their friends by chucking them under the chin.

They are great chewers of the betel-nut, and are very eager to obtain salt. They barter their produce occasionally with the Motu at Port Moresby for fish, cocoa-nuts, salt, and pottery.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 11, 1878.—In a valuable paper on the passage of the galvanic current through iron, Herr Auerbach describes experiments with reference to the effect of longitudinal magnetisation of iron bars or wires on their resistance, and to the extra currents at closing and opening of the circuit, explained by a transverse or circular magnetisation. Circularly magnetic iron conducts a current worse, the stronger the circular magnetisation. The resistance of longitudinally magnetised iron may be less or greater than that of unmagnetic; in the former case the resistance-function has nowhere a minimum or maximum; the resistance rises steadily from the state of saturated longitudinal, to that of saturated circular, magnetism; and this is realised in hard steel. In the other case the resistance-function has a minimum for the unmagnetic state. Herr Auerbach explains the effects observed on the hypothesis of rotatable molecular magnets, and indicates the bearing of his views on them on the fundamental laws of galvanism, and the galvanic constants of iron.—In a third series of experimental magnetic researches, Herr Fromme deals with two modes of magnetising a rod with a spiral conveying a galvanic current. It may be inserted in the spiral after the circuit has been completed, and withdrawn while the current is still flowing; or it may be inserted before the circuit is closed, and withdrawn after it is opened. He now obtains a distinct difference, unperceived before, between the effects, and the causes of the phenomena are thought to be not of secondary nature (or very little so), but deducible from the essence of magnetism. The results of experiment are found to agree better with the Neumann-Kirchhoff theory, when the latter of the two above methods is abandoned.—Herr Ritter communicates a first paper of researches on the height of the atmosphere, and the constitution of gaseous cosmical substances. On the two hypotheses of an indifferent state of equilibrium in the atmosphere, and of the oxygen and nitrogen retaining approximately, in all changes of condition, the properties of a so-called perfect gas, he arrives theoretically at a height of 40 km. for the atmosphere, whereas Schiaparelli's observations make it more than 200 km. He removes this discrepancy by supposing that, in the rise of the air-masses, not only aqueous vapour, but oxygen and nitrogen, pass into the state of aggregation of a snow-cloud.—Dr. Kolacek studies mathematically the influence of capillary surface-pressure on the velocity of propagation of water-waves.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 9.—"Note on the Inequalities of the Diurnal Range of the Declination Magnet as recorded at the Kew Observatory," by Balfour Stewart, F.R.S., Professor of Natural Philosophy in Owens College, Manchester, and William Dodgson.

We are at present engaged in searching for the natural inequalities of the above range, more especially for any of which the period is between 24 and 25 days. We find strong evidence of an inequality of considerable magnitude of which the period is 24·00 days, very nearly. We have also found preliminary evidence of the existence of two considerable inequalities having periods not very far from 24·65 and 24·80 days. These two appear to come together in about 11 years, but we cannot yet give the exact time of this.

We have not found a trace of any inequality with a period of 24·25 days.

"Some Experiments on Metallic Reflexion," by Sir John Conroy, Bart., M.A. Communicated by Prof. G. G. Stokes, Sec. R.S.

He finds that when light is reflected from a polished surface of gold or copper in contact with various media, the angle of principal incidence diminishes, and the principal azimuth increases with the increase of the refractive index of the medium in contact with the metallic surface; and further, the diminution in the value of the principal incidence appears to be nearly in proportion to the increase of the refractive index of the surrounding medium.

He states that the values of these angles for gold with red light are:—

	Principal Incidence.	Principal Azimuth.
	° ′	° ′
In air	76 0	35 27
In water	72 46	36 23
In carbon bisulphide	70 03	36 48

Assuming that the angle of principal incidence for a metal is the same as the angle of polarisation of a transparent substance, that is the angle whose tangent is equal to the refractive index, the value of that angle in air, as deduced from the measurements made in water and carbon bisulphide by multiplying the tangent of the principal incidence in those media by their refractive indices is 76·53 and 77·22 instead of 76.

"Researches on the Absorption of the Ultra-Violet Rays of the Spectrum by Organic Substances," by W. N. Hartley, F.Inst. Chem., F.R.S.E., F.C.S., Demonstrator of Chemistry, King's College, London, and A. K. Huntington, F.Inst. Chem., A.R.Sc. Mines, F.C.S. Communicated by Prof. G. G. Stokes, Sec.R.S.

The following were the conclusions reached:—

1. The normal alcohols of the series $C_nH_{2n}+_1OH$ are remarkable for transparency to the ultra-violet rays of the spectrum, pure methylic alcohol being as nearly so as water.

2. The normal fatty acids exhibit a greater absorption of the more refrangible rays of the ultra-violet spectrum than the normal alcohols containing the same number of carbon-atoms.

3. There is an increased absorption of the more refrangible rays corresponding to each increment of CH_2 in the molecule of the alcohols and acids.

4. Like the alcohols and acids, the ethereal salts derived from them are highly transparent to the ultra-violet rays, and do not exhibit absorption-bands.

In order to ascertain whether isomeric bodies exhibited similar or identical absorption-spectra, a series of benzene derivatives was examined. From the great absorptive power of this class of substances it was found necessary to use very dilute solutions, even though the cells holding the liquids were not more than 0·75 inch in thickness. Curves were plotted by taking the proportions of substances in solution as ordinates, and the position of absorption-bands as abscissæ, and these curves are highly characteristic features of very many compounds. About twenty diagrams have thus been made.

The following is a summary of the chief points of interest appertaining to benzene and its derivatives:—

1. Benzene, and the hydrocarbons, the phenols, acids, and amines derived therefrom, are remarkable firstly, for their powerful absorption of the ultra-violet rays; secondly, for the absorption-bands made visible by dissolving them in water or alcohol, and diluting; and thirdly, for the extraordinary intensity of these absorption-bands, that is to say, their power of resisting dilution.

2. Isomeric bodies, containing the benzene nucleus, exhibit widely different spectra, inasmuch as their absorption-bands vary in position and in intensity.

3. The photographic absorption spectra can be employed as a means of identifying organic substances, and as a most delicate test of their purity. The curves obtained by co-ordinating the extent of dilution with the position of the rays of the spectrum absorbed by the solution form a strongly-marked and often a highly characteristic feature of many organic compounds.

There is a curious feature in connection with the position of the absorption bands; at the less refrangible end they either begin at line 12 Cd or line 17 Cd, and those which begin at 12 end a little beyond 17.

No napthalene or anthracene derivatives have yet been examined, and very few substances of unknown constitution—hence most interesting results may be anticipated from a continuation of this research, and this contribution must be accepted rather as a bare commencement of the subject than its conclusion.

Mathematical Society, January 9.—C. W. Merrifield, F.R.S., president, in the chair.—Dr. J. Hopkinson, F.R.S., was admitted a Member.—The following communications were made to the Society: On a theorem in elliptical functions, by Prof. Cayley, F.R.S.—On a new modular equation, by Prof. H. J. S. Smith, F.R.S.—On coefficients of conduction and capacity of two electrified spheres, by Prof. Greenhill.—On certain systems of partial differential equations of the first order with several dependent variables, by Prof. Lloyd-Tanner.

EDINBURGH

Royal Society, December 16, 1878.—Prof. Kelland, president, in the chair.—The first paper was on the action of light on the iris, by Mr. William Ackroyd. In the paper Mr. Ackroyd suggested certain methods for determining whether the amount of light admitted to the eye had an influence on the pupil or not. Certain of the suggested methods had reference to light emanating from a bright point held close to the eye, while another dealt with rays of light emanating from a bright point at a distance.—The next paper was by Mr. John Aitken, on a new variety of ocular spectrum.—Mr. Alex. Macfarlane, D.Sc., M.A., then read the first half of a paper on the principles of the logical algebra. In it he entered into a minute examination of the principles of the logical calculus, as laid down by Prof. Boole in his treatise on the "Laws of Thought," and advanced a new theory of the operation of the mind, founded upon the analysis of language and the nature of mathematical reasoning.

MANCHESTER

Literary and Philosophical Society, December 10, 1878.—J. P. Joule, D.C.L., LL.D., F.R.S., president, in the chair. On the combinations of aurin with mineral acids, by R. S. Dale, B.A., and C. Schorlemmer, F.R.S.—On the estimation of small excesses of weight by the balance from the time of vibration and the angular deflection of the beam, by J. H. Poynting, B.A., B.Sc.

PARIS

Academy of Sciences, January 6.—M. Fizeau in the chair.—M. Edm. Becquerel was elected Vice-President for 1879.—M. Fizeau gave information regarding the publications of the Academy, and the changes among members and correspondents during the year. The deceased members are Becquerel, Regnault, Delafosse, Bernard, Belgrand, and Bienaymé. Deceased correspondents, Didion, Secchi, Mayer, Malaguti, Leymerie, De Vibraye, De Valdrôme, Shumann, Rokitanski, and Lebert.—The following papers were read:—Reply to M. Pasteur, by M. Berthelot.—On a gigantic isopod from a great depth in the sea, by M. Milne-Edwards. This creature, called *Bathynomus giganteus*, was brought up from a depth of 955 fathoms, on the north-east of the bank of Yucatan, by the American expedition in the *Blake*, which started in December, 1877, under A. Agassiz. It measures 0·23m. in length and 0·10m. in breadth, and is specially distinguished by its respiratory apparatus. This has the form of plumes or tufts from branching stems under the false abdominal feet, which serve as a kind of opercular system. The whole system, including a hollow part in the false abdominal feet, may be injected with coloured liquid. Doubtless the arrangement is specially adapted for the great depth at which the animal respires. The eyes are very well-developed (which would hardly have been expected in a very dark medium). They are each formed of nearly 4,000 square facettes, and, instead of being above the head, as in all errant Cymothoadians, they are lodged under the frontal border, at each side of the base of the antennæ. M. Milne-Edwards places the animal in a new family, which he designates *Branchiferous Cymothoadians*.—On the parallelism of axes of rotation, by M. Sire. The tendency to this is illustrated by a simple apparatus.—On an economical method of bathing adopted in the 69th Regiment of Infantry, by Dr. Haro. Each man takes his place in a tub of warm water, and receives a pulverulent douche of warm water, at the same time rubbing himself with black soap and a brush; then comes a second douche of warm water, then washing with cold water. 80 to 100 men are thus washed daily at a cost of 1 fr. 20 per *séance*, or 0·012 fr. per man.—On the existence of the intra-Mercurial planet indicated by Leverrier, by M. von Oppolzer. He finds (by calculation) the existence of such a planet very probable, but thinks it cannot be identical with any of the two objects observed by Mr. Watson.—Double nebulæ in motion, by M. Flammarion. He suggests that such may be the origin of systems of double stars. Having compared the observations made on 5,000 catalogued nebulæ, he indicates those which show a certain motion, and the nature of it.—On the formation of organic ultramarines, by M. de Forcrand. He obtains such products by heating ultramarine of silver with chlorides or iodides of different alcoholic radicles.—On the separation of ethylamines, by MM. Duvillier and Buisine.—On a new group of silicified stems of the coal epoch, by M. Renault. Completing, in some sort, the observations of Prof. Williamson, he finds among the fossils of Autun a series of types parallel (as regards the growth of the ligneous axis) to the Sigillarineæ, but related, on the other hand, to stems of Cordaites by certain details of structure. This new group he designates *Poroxyleæ*, from the nature of their wood; they present the three types of stem found in Sigillarineæ.—On the disease of the chestnuts, by M. De Seynes. The parasite mycelium forms a superficial and a deep network, which destroy the cellular layers of the root, the richest in protoplasm; the liberian and ligneous fibres are not attacked.—On dental grafting, by M. David. He distinguishes the graft by *restitution* and the graft by *borrowing*. The former consists in reimplantation after extraction, and is resorted to to rectify direction, to treat caries and periostitis easily, or to facilitate operations on some other tooth in the mouth. In twenty-two cases, only one proved unsuccessful. The graft by borrowing consists in substituting a sound tooth (which has had to be extracted from the same or another mouth), for a bad one. Or a sound root from a lower animal may be inserted for a bad one, as base for a pivoted artificial tooth.—On animal grafting in its applications to the therapeutics of certain lesions of the dental apparatus, by M. Magitot. He furnishes some data regarding graft by restitution in the case of chronic periostitis of the top of the root of teeth, &c. His success amounts to about 92 per cent. (sixty-two operations, fifty-seven cures).—M. Delesse was elected member in mineralogy, in room of the late M. Delafosse.

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